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This report develops quantitative models for relating emissions of air pollutants to their effects on people and uses the methodology for a determination of the relative importance of sources of air pollution.

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POPEX

RANKING AIR POLLUTION SOURCES BY POPULATION EXPOSURE

by

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TABLE OF CONTENTS

CHAPTER

PAGE

LIST OF TABLES viii

LIST OF FIGURES. xi

SUMMARY. xiii

I. INTRODUCTION 1

STATEMENT OF THE PROBLEM 1

OBJECTIVES 2

DEFINITIONS. 2

JUSTIFICATION AND SIGNIFICANCE 4

APPROACH AND SCOPE 6

FORMAT OF PRESENTATION 7

II. AIR QUALITY MANAGEMENT SYSTEM. 9

DEFINITION OF A SYSTEM FOR AIR QUALITY MANAGEMENT. . . 9

UNCERTAINTIES IN THE AIR QUALITY MANAGEMENT SYSTEM . . 12

III. MODELING 16

INTRODUCTION 16

QUANTITATION OF UNCERTAINTIES. 17

RATIONALE. 25

SELECTION OF PARAMETERS AND DESCRIPTION. 28

FLOW DIAGRAM 35

DEVELOPMENT OF SUBMODELS 38

Table of Contents (cont)

Chapter Page

IV. DISPERSION SUBMODEL. 40

INTRODUCTION 40

DEVELOPMENT. 43

V. POPULATION SUBMODEL. 61

INTRODUCTION 61

DEVELOPMENT. 61

VI. HEALTH-EFFECTS SUBMODEL. 66

INTRODUCTION 66

DEVELOPMENT. 67

VII. COMPUTER MODELS AND INPUT DATA 81

COMPUTER MODEL: POPEX 81

COMPUTER MODELS: MASS INDEX AND PINDEX. 88

INPUT DATA 88

VIII. RESULTS OF THE POPEX MODEL 92

FORMAT OF RESULTS. 92

RESULTS. 129

IX. SENSITIVITY ANALYSIS OF THE POPEX MODEL. 146

METHOD 146

RESULTS. 148

DISCUSSION 151

X. IMPLICATIONS OF THE METHODOLOGY. 154

APPROACH 154

IMPLICATIONS 175

LIMITATIONS OF THE POPEX MODEL 176

Table of Contents (cont)

Chapter   Page

FUTURE WORK 177

XI. CONCLUSIONS 179

LIST OF REFERENCES. 182

APPENDIX A: ASSESSMENT OF EXISTING STUDIES OF HEALTH EFFECTS OF AIR POLLUTION. 187

SUMMARY 187

INTRODUCTION. 188

EXPERIMENTAL STUDIES (A3-A11) 195

EPIDEMIOLOGICAL STUDIES - GROUP 1 - CORRELATION STUDIES (A16-A20) 210

EPIDEMIOLOGICAL STUDIES - GROUP 2 - CROSS-SECTIONAL STUDIES (A21-A25) 213

EPIDEMIOLOGICAL STUDIES - GROUP 3 - LONGITUDINAL STUDIES (A26-A31) 217

COMMENTS. 219

ASSESSMENT OF HEALTH-EFFECT STUDIES 230

CONCLUSIONS 233

LIST OF REFERENCES FOR APPENDIX A 236

APPENDIX B: LISTING OF THE COMPUTER PROGRAM. 241

APPENDIX C: LISTING OF THE SOURCE-CATEGORY NUMBERS AND THE SOURCE CLASSIFICATION CODES (SCC) 264

APPENDIX D: EMISSIONS DATA FOR SOURCES OF AIR POLLUTION IN THE CHICAGO AQCR 293

Table of Contents (cont)

Chapter Page

APPENDIX E: MAXIMUM POSSIBLE CHANGE IN TWO SETS OF POPEX VALUES 325

LIST OF TABLES

TABLE PAGE

I. PARAMETERS FOR EXPOSURE MODELING 26

II. COMPARISON OF UNITED STATES AND CHICAGO AQCR EMISSIONS 32

III. DEMOGRAPHIC DATA FOR CHICAGO AQCR (27) 36

IV. ANNUAL RESULTANT WINDSPEEDS AND DIRECTIONS FOR CHICAGO 45

V. EQUATIONS FOR ANGLE θ IN THE DISPERSION SUBMODEL . . 59

VI. AIR QUALITY STANDARDS AND TOLERANCE FACTORS (IN $\mu g/m^3$) 69

VII. DERIVATION OF TOLERANCE FACTORS 75

VIII. EXPLANATIONS OF VARIABLES USED IN THE COMPUTER PROGRAM 82

IX. EMISSIONS DATA FOR COUNTIES IN THE CHICAGO AQCR IN TONS/YEAR OBTAINED FROM APPENDIX D 90

X. EMISSIONS AND RESULTS OF MASS INDEX, PINDEX AND POPEX FOR EACH OF THE SOURCE-CATEGORIES IN THE CHICAGO AQCR 93

XI. CHICAGO AQCR SOURCE-CATEGORIES IN THE DECREASING ORDER OF POPEX 122

XII. ASSIGNMENT OF RANKS BASED ON PERCENT CONTRIBUTIONS OF EACH OF THE SOURCE CATEGORIES TO POPEX, PINDEX AND MASS INDEX 129

XIII. POPEX - RANK-GROUPS 130

XIV. SOURCE-CATEGORIES IN POPEX-RANK-GROUP ONE 133

XV. SUMMARY TABLE FOR POINT SOURCES IN POPEX-RANK-GROUP ONE 136

List of Tables (cont)

Table Page

XVI. SOURCE-CATEGORIES IN POPEX-RANK-GROUP TWO 144

XVII. RESULTS OF THE SENSITIVITY ANALYSIS 149

XVIII. INDICES, PI/MI, PO/PI AND SOURCE LOCATIONS FOR SOURCE CATEGORIES IN CHIAGO AQCR 157

XIX. POPULATION DENSITIES AND SLOPES OF PO/PI VERSUS STACK HEIGHTS FOR SIX COUNTIES 173

APPENDIX A

A-I. LUNG VOLUMES, CAPACITIES AND PULMONARY FUNCTION MEASUREMENTS: NOMENCLATURE AND DEFINITIONS (A1) 190

A-II. CRITERIA FOR EVALUATION OF OBSTRUCTION PULMONARY DISEASES 193

A-III. THE GROUPING OF HEALTH-EFFECT STUDIES 195

A-IV. SUMMARY OF THE EXPERIMENTAL STUDIES 196

A-V. CHANGES IN LEVEL OF SIGNIFICANCE DUE TO A CHANGE IN DURATION OF EXPOSURES OF SMOKERS AND NONSMOKERS TO 0.37 PPM OZONE (A6) 203

A-VI. EFFECT OF OZONE AND EXERCISE ON THE PULMONARY FUNCTION OF MALE ADULTS 206

A-VII. SEQUENTIAL EXPOSURE OF OZONE, NITROGEN DIOXIDE AND CARBON MONOXIDE TO ADULT MALES 208

A-VIII. EPIDEMIOLOGICAL STUDIES: GROUP 1 - CORRELATION STUDIES 211

A-IX. EPIDEMIOLOGICAL STUDIES: GROUP 2 - CROSS-SECTIONAL STUDIES 215

A-X. EPIDEMIOLOGICAL STUDIES: GROUP 3 - LONGITUDINAL STUDIES 218

A-XI. SOME OF THE ACCEPTABLE METHODS FOR MONITORING OF GASEOUS AIR POLLUTANTS 222

A-XII. DISTRIBUTION OF THE USE OF PULMONARY FUNCTION TESTS IN THE STUDIES REVIEWED 224

List of Tables

Table | Page

A-XIII. PROPORTION OF HYPERACTIVE POPULATIONS IN SELECT EXPERIMENTAL AND EPIDEMIOLOGICAL STUDIES 229

A-XIV. RESULTS OF ASSESSMENT OF THE HEALTH-EFFECT STUDIES 232

LIST OF FIGURES

FIGURE PAGE

1. A system for air quality management 10

2. Representation of relative uncertainty in processes and phenomena 19

3. Representation of relative uncertainty in data bases 22

4. Representation of relative extent of knowledge of processes, phenomena and data bases associated with the air quality management system 24

5. Map of Chicago air quality control region (AQCR number 67, Illinois-Indiana) 31

6. Popex flow diagram 37

7. Plume model 42

8. Airport locations in Chicago AQCR for wind data . . . 46

9. Wind roses for different locations in Chicago AQCR for June 5, 1975 (9 am to 9 pm) 48

10. Wind roses for different locations in Chicago AQCR for June 7, 1975 (9 am to 9 pm) 49

11. Wind roses for different locations in Chicago AQCR for July 29, 1975 (9 am to 9 pm) 50

12. Wind roses for different locations in Chicago AQCR for July 27, 1975 (6 am to 9 pm) 51

13. Wind directions at three-hour intervals for different locations in Chicago AQCR on July 27, 1975 52

14. Pollutant trajectory in a lake breeze, adapted from (32) 54

List of Figures (cont)

Figure **Page**

15. Wind rose data for Dresden nuclear power station of Commonwealth Edison Company, 1972 (33) 55

16. Flow diagram: development of dispersion submodel 58

17. Flow diagram: development of population submodel 63

18. Sensitivity analysis and improvement of population submodel 65

19. Concentration versus averaging time for sulfur dioxide 71

20. Standards and tolerance factors for sulfur dioxide 73

21. Flow diagram of popex computer model 87

22. Locations of the centers of counties in the Chicago AQCR and their x and y coordinates 91

23. Indices and variables 155

24. Plots of stack heights versus PO/PI for different counties 172

25. Relationships of PO/PI versus population density for different stack heights 174

APPENDIX A

A-1. Dose-response curve for two hours of exposure to ozone for adults 200

A-2. Effect of combination of cumulative exposures and duration of exposures on four "reactive" adult males (A8) 202

A-3. Dose-response curve for ozone: effect of durations of exposures 204

A-4. Dose-response curves for adult males for six-hours of exposure to SO_2 209

A-5. Dose-response curve of nitrogen dioxide for children of age eleven years 214

SUMMARY

The goal of this research was to develop quantitative models for relating emissions of air pollutants to their effects on people and to use the methodology for a determination of the relative importance of sources of air pollution.

The quantitative methodology for the ranking of sources developed in this project includes considerations of the dispersion of air pollutants, exposure of people, and the subsequent health effects. The computer model, called popex, consists of three submodels: dispersion, population exposure, and health effects. Optimal sophistication and balance of details among the submodels were emphasized in this integrative computer model.

The popex model was applied to sources of air pollution in the Chicago Air Quality Control Region. The results show that seventeen out of a total of 227 categories of sources contribute nearly 80 percent to the total air-pollution-population-effect problem. These seventeen categories include commonly recognized large sources, such as automobiles, large utility and industrial boilers, as well as less-recognized categories, such as solvent evaporation from industrial operations involving surface coatings.

A sensitivity analysis of the popex model revealed that the results of the popex model are most sensitive to parameters related to health effects. Other parameters, including the ones related to the

dispersion of air pollutants, were found to have a lesser influence on the outcome of the model. Past studies related to health-effects of air pollution, specifically studies in which health-effects were characterized by the pulmonary function tests, were reviewed and analyzed for possible improvements in the modeling of health effects.

Finally, based on the methodology developed in this project, a simpler method for evaluating relative impacts of a smaller number of sources is proposed.

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This report has been assigned to the ENVIRONMENTAL PROTECTION TECHNOLOGY series. This series describes research performed to develop and demonstrate instrumentation, equipment, and methodology to repair or prevent environmental degradation from point and non-point sources of pollution. This work provides the new or improved technology required for the control and treatment of pollution sources to meet environmental quality standards.

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CHAPTER 1

INTRODUCTION

STATEMENT OF THE PROBLEM

Air pollution causes many deleterious effects, the most important of which is its adverse impact on human health. There are numerous sources of air pollution, and in order to reduce health risks to the exposed human population, emissions of air pollutants from these sources have to be controlled.

For an efficient strategy for control of air pollutant emissions, a system for quantitatively relating emissions to their health effects is necessary. Air quality and its health-effect implications are extremely complex functions of many variables, and such a quantitative methodology, despite the obvious need, does not exist. The significant areas of difficulty which underscore the lack of availability of quantitative methodology include: (a) the duration of varying levels of concentration of air pollutants to which people are exposed cannot be precisely estimated, and (b) significant uncertainty exists in the quantification of the health effects of exposure to air pollution.

In this research some of these difficulties are addressed. Modeling of air pollution-population exposures and evaluation of their health effects for prioritization of sources of air pollution comprises this dissertation.

OBJECTIVES

The aim of this research was to develop and to use a "first generation" quantitative methodology for determination of the relative importance of sources of air pollution. The objectives of this study were as follows:

1. Construct a mathematical model which relates source emissions to population-pollutant exposures. This computerized model should include air pollution emission, meteorologic, spatial, population, and health-effect parameters.

2. Use this model to assign rank-priority to sources of air pollution.

3. Perform sensitivity analysis or analyze the model for sensitivity of its results to changes in input parameters. Study in-depth the sensitive parameters thus identified.

DEFINITIONS

Air Pollution

Air pollution is defined as the presence in the atmosphere of one or more contaminants (dust, fumes, gas, mist, odor, smoke, or vapor) in quantities, of characteristics, and of duration such as to be injurious to human, plant or animal life, or to property, or which unreasonably interferes with the comfortable enjoyment of life and property (1). The following air pollutants are included in this study: particulate matter, PM; sulfur dioxide, SO_2; nitrogen oxides, NO_x; hydrocarbons, HC; carbon monoxide, CO; and oxidants, Ox. The first five of these are considered as primary pollutants or the pollutants which are directly emitted by sources of air pollution. Secondary pollutants, like oxidants, are formed within the atmosphere from primary pollutants and other substances through a set of complex chemical reactions.

There are numerous sources of air pollution. Both point sources (which are rather large readily identifiable sources, such as power plants, petroleum refineries, etc.) and area sources (which represent collectively a large number of smaller sources distributed over a well-defined area, such as residential heating) are included. Air pollutants emitted by these sources diffuse and decay in the atmosphere. The diffusion process is dependent on meteorology and topography of the region. Air quality is the result of this diffusion process. The diffusion of air pollutants can be simulated to a limited extent by mathematical modeling.

Health Effects

The effects of air pollution on personal or community health could range from eye irritation to acute illness or death (2). Basically, two approaches are used in studying health effects of air pollutants: human and animal experimental studies and epidemiological studies. The duration of exposures involved in experimental studies with humans are generally less than a few days at a time. Epidemiological studies enable evaluation of longer-term effects. The design of the air pollution epidemiologic studies is difficult; many causative factors could simultaneously super-impose their impact on end-effects which are similar to the effects of air pollutants. Researchers in the past few years have been able to "isolate" the effects of air pollution on health with varying degrees of success. Their studies have shown that the level of effects depends on many factors including concentrations of the air pollutants, durations of exposures and susceptibility of the host.

Modeling

Mathematical models consist of sets of mathematical expressions arranged in a logical format. To obtain a predesignated output, various predefined inputs are fed into the model at various stages. The mathematical expressions in the model could be in an analytical or empirical form, and they are designed to simulate the process being modeled. The use of modeling enables one to predict results of a complex process with less time and effort. Modeling also has two other distinct advantages. First, modeling provides an opportunity to see the interactions between directly unrelated parameters. This allows, one to judge the importance of results of variations in one parameter against others. A second, and generally less well recognized advantage of modeling, is that it shows explicitly the "missing links" in the whole system being modeled.

JUSTIFICATION AND SIGNIFICANCE

Attempts have been made in the past to model segments of the air quality management system, such as modeling of the dispersion of pollutants in the atmosphere, modeling of atmospheric reactions related to pollutants, etc. There also have been attempts to model a large part of the "overall" air pollution system. These models have been of significant use for the understanding of air pollution. However, generally, these models have considered artificially structured situations instead of actual ones. In some instances, prior studies have considered either real geographic and topographic data for atmospheric dispersion, or actual population data for estimating population exposures. Models which use both real dispersion and population data are not available. Similarly, models of health effects have been conspicuously absent from the overall models of air pollution.

This research project was aimed at the construction of a quantitative methodology for determining the relative importance of various sources of air pollution. While many simplifying assumptions were made, actual data on sources and population were used. This project represents a "first generation" attempt to integrate diverse factors. The results of the methodology and the model presented here are in the form of a ranking of relative importance of categories of sources of air pollution. These rankings could be directly used in decision making processes for determining the degree of control of emissions as well as in developing priorities in research and development related to the technology of control systems.

It must be pointed out that at least two different groups (3,4) have performed research in this area of prioritization of sources of air pollution. One study (3) was restricted to an evaluation of sources of nitrogen oxides. Their evaluation was based on the sensitivity of changes in ambient air quality to changes in the nitrogen oxides emissions. An important limitation of the study was that the consideration of atmospheric transformations of nitrogen oxides to oxidants was not included and thus the results of the study are of a limited value.

Another more useful study performed by Monsanto Research Corporation (4) evaluates industrial sources of air pollution. On this study in addition to the five primary pollutants mentioned earlier, other toxic industrial pollutants were considered. Atmospheric transformations of pollutants were not considered. Similarly, only nonmetallurgical industrial sources were evaluated.

In the present study all known sources of the five pollutants: PM, SO_2, NO_x, CO, HC are evaluated. Considerations of formation of oxidants are also included. The approach and the scope of this study are briefly described below.

APPROACH AND SCOPE

An attempt is made in this dissertation to combine numerous factors--all related to air pollution and its effects--for the development of a quantitative methodology which enables the evaluation of the relative importance of different sources of air pollution. The approach that was used toward achieving this goal was that of systems analysis. Briefly, the steps included in this approach were (a) defining the system, (b) analysis and simplification of the technical information relevant to the system as well as to parts of the system, (c) modeling or integration of this information in a systematic and quantitative manner.

To the extent feasible, reliance was placed on the available data and information. Where data were not available, approximations and assumptions were made. Gathering of data through survey or other techniques was not attempted. Statistical methods were used to obtain empirical relationship from complex sets of analytical expressions.

The quantitative system or the model thus developed was applied to actual conditions. The results were then analyzed and interpreted with special reference to the simplifications and assumptions used in developing the model.

FORMAT OF PRESENTATION

A system for air quality management is defined and many uncertainties associated with this system are described in Chapter II. Chapter III analyzes some of these uncertainties, provides a rationale for construction of the model and includes a brief description of the population-exposure model called "popex". The details on the construction of various submodels are given in the subsequent three chapters. Chapter VII describes the computer algorithm and the input data.

The results of the popex model in the form of rankings of sources are given in Chapter VIII. Chapter IX provides sensitivity analysis. Implications of the popex methodology, limitations of the popex model and discussion of future projects are given in Chapter X. The conclusions of this research work are presented in Chapter XI.

A reader whose primary interests are in the actual rankings of sources of air pollution are referred directly to Chapters VIII and XI. A reader interested in methodology should first read Chapters II, III, and VIII to XI and then refer to the three chapters (IV to VI) on construction of submodels as necessary. Individuals interested in modeling of health effects are referred to Chapters VI, IX, and to the Appendix A.

CHAPTER II

AIR QUALITY MANAGEMENT SYSTEM

The goal of this dissertation research was to develop methodologies which can assess, in a systematic and quantitative way, the adverse effects of air pollution and relate them back to individual sources of air pollution. Thus, a definition of the system and understanding of uncertainties in this system were considered to be of significant importance. In this chapter, a system for air quality management is defined and uncertainties in this system are discussed.

An all-inclusive system for the management of air quality would involve many disciplines such as physical and life sciences, engineering, and economics, etc. This system would also include the administrative and regulatory aspects of management. Such a definition of the system is, no doubt, too broad for this research. A somewhat narrower definition, which is more relevant to the goals of this work, is given in the next section. A brief discussion of uncertainties in the air quality system is also included later in this chapter.

DEFINITION OF A SYSTEM FOR AIR QUALITY MANAGEMENT

Figure 1 gives a basic idea of different aspects of air quality management. As shown in Figure 1, emissions from various sources of air pollution, the meteorology of the region, and the chemical reactions of the pollutants in the atmosphere primarily influence the air quality

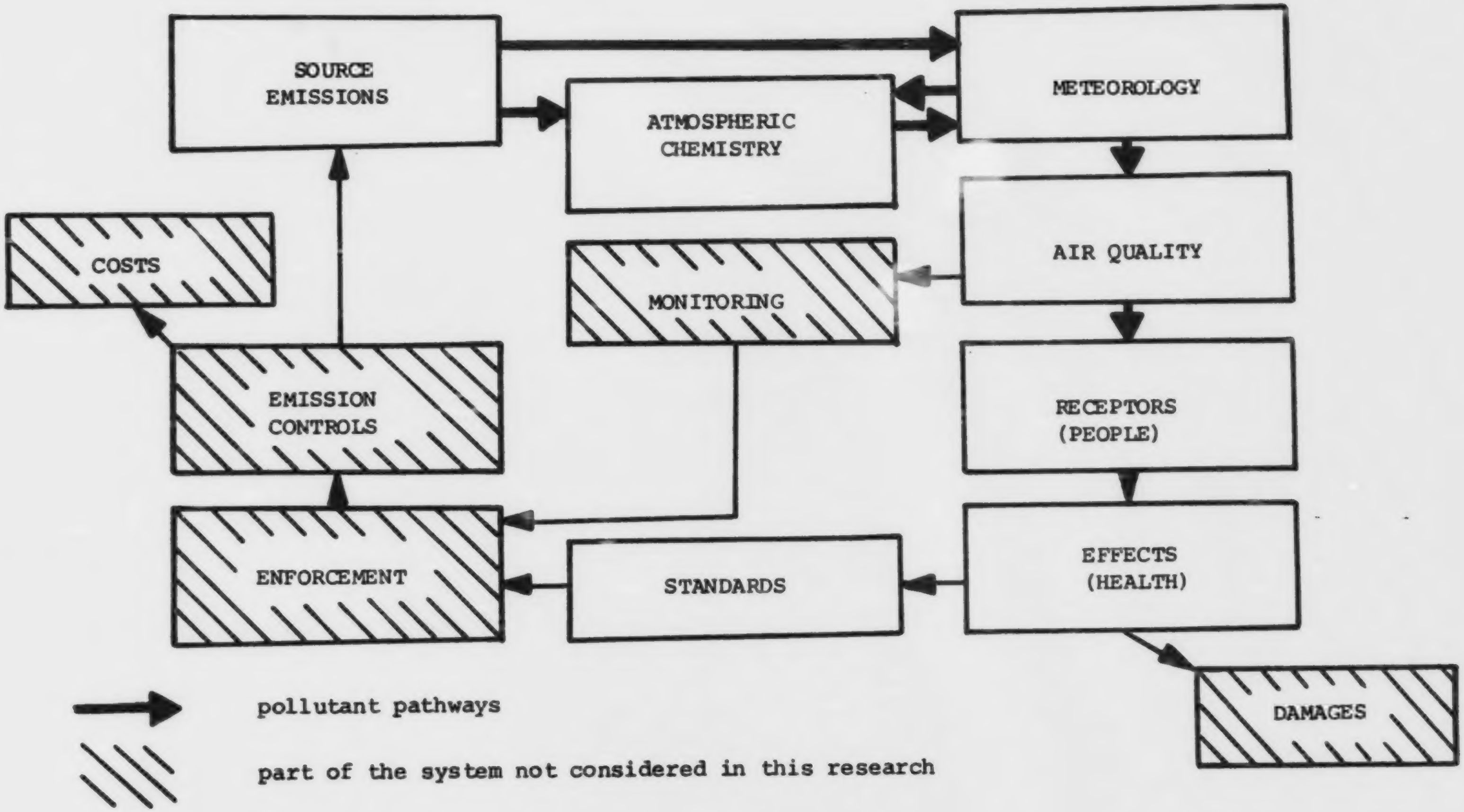
SOURCE EMISSIONS
ATMOSPHERIC CHEMISTRY
METEOROLOGY
AIR QUALITY
MONITORING
COSTS
EMISSION CONTROLS
RECEPTORS (PEOPLE)
ENFORCEMENT
STANDARDS
EFFECTS (HEALTH)
DAMAGES
pollutant pathways
part of the system not considered in this research

Figure 1. A system for air quality management.

of that region. The air quality at the receptor locations, or the air quality experienced by individuals, depends on many factors. The "location" of an individual with reference to distances from various emission sources is important. This "location" parameter is dynamic in nature and exposures to pollutants would depend on the length of time spent by the individual at his residence, place of work, in shopping, and so on. Other factors, such as differences in indoor and outdoor air quality, also influence the dosages of exposure to air pollutants. These repeated exposures cause varied effects on the health and well-being of the individual. Exposure to air pollutants also cause damage to plants, animals, and property. Effects other than on human health are not included in this system but could be added at any time in the future.

The health effects are dependent on the degree and nature of air pollutant dosages as well as on other factors including age, susceptibility, and work load of the individual. As the box at the bottom of Figure 1 indicates, these health effects are responsible for "damages". These health-related damages are not limited to direct consequences of ill health but would include indirect costs such as decrease in lifespan of an individual, or an increased possibility of a future disease due to air pollution.

The efforts in the direction of reducing air pollution have been underway for many years. However, the enactment of the Clean Air Act Amendments in 1970 has helped to make the process proceed faster and be better organized. The shaded portion of Figure 1 shows a major part of the endeavor to reduce air pollution through the monitoring of the air quality, establishment of standards, and enforcement and maintenance of the standards. In order to meet the ambient or emission standards, the air pollution emissions are controlled by installing control devices on the existing processes, or through process modifications. Another approach, not shown in Figure 1, would be through better land use policies. Generally, there is a positive cost associated with most of these mechanisms to reduce air pollution and at every level of control; ideally, this control cost has to be compared with the negative cost of better health due to reduction in air pollution. In the remainder of this dissertation, the shaded part of Figure 1 is excluded and only the unshaded portion is addressed.

Although the air quality management system was described here in a very simple way, there are many uncertainties associated with most of the boxes and arrows depicted on Figure 1.

UNCERTAINTIES IN THE AIR QUALITY MANAGEMENT SYSTEM

Pollutant Transport Mechanisms

Meteorological dispersion models with various levels of sophistication can be employed for the estimation of pollutant concentrations at receptor sites (5,6). Such models all require some form of calibration and have to be verified for complex urban situations. Compounding the difficulty, the large amounts of prerequisite meaningful meteorological data are virtually nonexistent.

Interaction of Pollutants

In the atmosphere, pollutants react with other pollutants as well as with other materials. These reactions could produce more-potent or less-potent intermediates, leading to particulate matter which is eventually removed from the atmosphere, or to innocuous decay end products, such as carbon dioxide and water. Some systems are understood better than others. Oxidant formation has been the subject of intensive study (7,8) but similar work is just beginning to shed light on the mechanisms involved in the atmospheric conversion of sulfur dioxide (9) and nitrogen oxides into possibly more toxic sulfates and nitrates. None of the systems are understood sufficiently to permit the reliable prediction of actual atmospheric reaction rates.

Source-Receptor Geometry:

In order to arrive at an estimate of pollutant dosage, source-receptor geometry must be considered. Residences are not distributed evenly throughout a region, and inhabitants do not spend all their time near home. Exposures to pollutants during travel in an automobile (10) could be significantly different from either the air quality at the starting point or at the destination. Similarly, pedestrians and street-workers in a downtown business district are exposed to high levels of air pollution (11). There are also differentials between indoor and outdoor air quality (12), and these are only now increasingly being recognized (13,14). Furthermore, monitoring stations which, of course, can not adequately represent overall pollutant exposures, often are in a location which is totally unrepresentative of the air quality of that region.

Health Effects

Numerous experimental and epidemiologic studies have been performed on characterization of the health effects of air pollution. Most of these studies are able to show a qualitative relationship between increase in air pollution and increase in adverse effects.

In the experimental studies the effects have been studied at different organizational levels: biochemical, ultrastructural, tissue, organ, etc. Given the complexity, it is not surprising that there are numerous uncertainties associated with effects at all levels. Ideally, it would also be of great value if the concentrations of pollutants were known at which the normal homeostatic and compensatory mechanisms are no longer adequate and some very difficult-to-detect (sub-subclinical) effects are initiated (15). It appears that these types of studies have been performed by Soviet scientists (16,17), but exact implications of the Soviet studies, when compared with other studies, remain unclear.

Compounding these difficulties is the fact that exposure to air pollution is seldom comprised of a single pollutant. The effects of a combination of pollutants or a pollutant with other environmental stresses could be synergistic, additive, or in a rare case, even inhibitory. The uncertainties associated with a single pollutant are magnified when multiple pollutant exposures, as in the case of ambient air pollution, are involved.

An even larger number of variables are generally included in epidemiologic studies. The design of air pollution epidemiologic studies is difficult. Two of the specific uncertainties related to these studies include difficulty associated with quantification of long-term effects of pollutants at the levels near the ambient concentration of pollutants and characterization of segments of the population which may be hypersusceptible to environmental stressors, including air pollutants.

CHAPTER III

MODELING

INTRODUCTION

The aim of this project was to construct a model which relates source emissions to their effects on people and to use this model to assign a rank-priority to sources of air pollution. In order to relate emissions to health effects, intermediate steps of atmospheric transport and atmospheric conversion as well as population-pollution exposure need to be included in the model. Quite often these intermediate steps or submodels are so large and complex that each one of the submodels may require the full thrust of an investigator's efforts.

Atmospheric dispersion of air pollutants has been a subject of numerous investigations and the models for dispersion are available (18,19). Due to the sheer size and complexities of such models, the application of these existing models for ranking sources is difficult. Similarly, the exposure model must include diverse phenomena such as atmospheric dispersion of pollutants and their health effects. For a model to be useful, the accuracy of one part of the model must be balanced with the remainder. Simplifications in the complex pollution-population-effect interactions are also necessary to have a workable model. Thus, a direct use of existing dispersion models was ruled out for this project.

In this chapter, uncertainties mentioned in the previous chapter are analyzed, the desired optimum degree of complexity of the overall model is discussed, and the rationale for the selection of parameters and their data bases for modeling is briefly described. Finally, a brief description of the model is included and the simplified flow diagram of the model is explained.

QUANTITATION OF UNCERTAINTIES

This subjective quantitation of uncertainties is based on the discussion of uncertainties in the preceding chapter and on the writer's understanding of the air quality management system. It is possible that different workers could view these uncertainties in different ways depending on their background as well as their biases. However, the writer feels that even with differing viewpoints the basic qualitative picture of the quantitative representation of uncertainties described below, will remain essentially the same.

Two forms of uncertainties are encountered: uncertainty associated with processes or phenomena and uncertainty in data. An example of the former is the precise mathematical estimation of concentration of a non-reacting pollutant, in that the process or mechanism of dispersion has to be well understood and be mathematically definable. As an example of the latter, adequate data for various parameters, such as rates of emission, location of sources, and several meteorological parameters, are required when a dispersion model is used. Accuracy of estimation of concentration would then depend on two factors; first, how close does the mathematical simulation or the model of the process resemble the actual one, and second, whether qualitatively acceptable and quantitatively sufficient data are available for input into the model.

Uncertainty in Phenomena

The modeling of population-pollutant exposure and health effects for setting source-control priorities basically requires the knowledge of concentration of air pollutants at various locations, number of people exposed along with the levels of concentration to which they are exposed and the consequent health effects. In other words, three processes or phenomena have to be well characterized: dispersion (including atmospheric conversions), source-receptor geometry, and the dose-response relationships of the health effects.

A scale of zero to ten is used to characterize relative uncertainty, with zero reflecting the least and ten the highest degree of uncertainty. As mentioned earlier, this quantitation of uncertainties is necessarily subjective and is attempted only with the goal of achieving a balance of complexities and sophistication in the different aspects of the model.

Figure 2 ranks the degree of uncertainty related to the processes. Health effects are rated ten on the uncertainty scale since there are no generalized dose-response data available for effects at air pollutant concentrations approaching ambient conditions. On the other hand, dispersion of a non-reacting (or very slowly reacting) pollutant from a single source or multiple sources in flat topographic regions can be estimated with reasonable accuracy (20). Thus dispersion is rated at one on the uncertainty scale which implies that there is a finite but

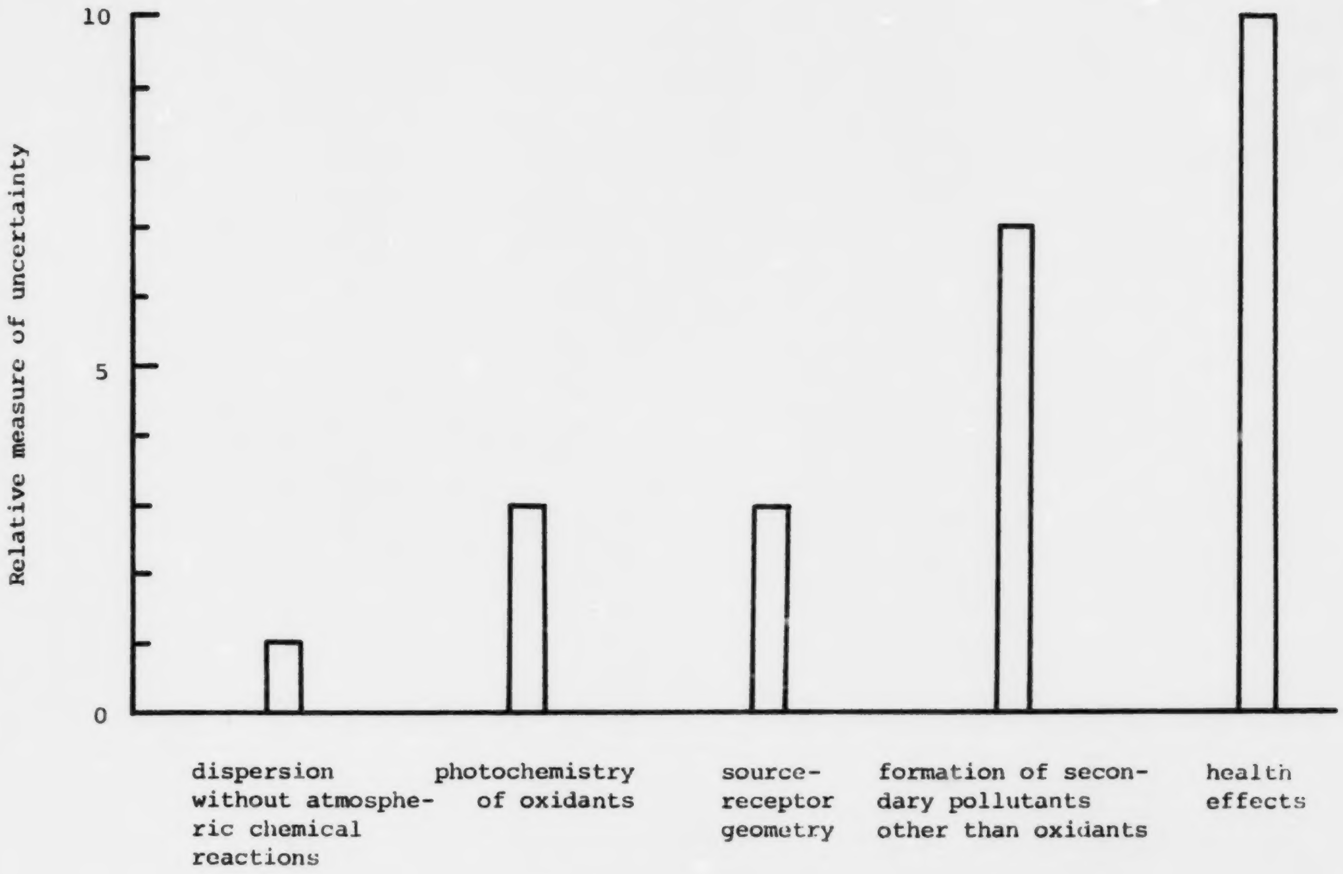

Figure 2. Representation of relative uncertainty in processes and phenomena.

quite small uncertainty associated with simple dispersion of the pollutant. The mechanism of oxidant formation is less well established than dispersion. Models for prediction of formation of oxidant are available (21). However, the accuracy of estimation is less than that for estimation of simple dispersion. Oxidant formation is thus ranked at three. Mechanisms for formation of secondary pollutants such as sulfates are not as well understood as for formation of oxidants, but some correlations between sulfates and their precursors are available (22). Since formation of secondary pollutants other than oxidants can be estimated to a limited extent, and few mathematical relationships for health effects are available, formation of secondary pollutants is rated at seven, or in between oxidant formation and health effects.

The dynamics of source-receptor geometry poses a unique problem for uncertainty rating, since a model for source-receptor geometry is not difficult to visualize and basic data, i.e., population and source data, for construction of such a model are available. However, little work has been done to develop a generalized model in this area. Thus, modeling source-receptor geometry is feasible, but since the models are not available, an uncertainty rating of three is assigned.

Uncertainty in Data

Three major data-bases are required for modeling of pollutant exposure and health effects: emissions, meteorology, and population characteristics. Of these three, the data on population are best known. In the United States, the census of population has been taken every ten years since 1790 (23). Over the years, methods of taking a census have been refined and machinery for good statistical quality control has been established. Thus, among the three data bases, it is by far the best both in terms of completeness as well as in terms of quality of the data. Population data-base is assigned the best rating of one on the uncertainty scale of, again, zero to ten (Figure 3).

The National Emissions Data System (NEDS) of U. S. Environmental Protection Agency (EPA) has been in operation for the last few years. NEDS systems compiles emission inventories based on information supplied by local and state air pollution control agencies. Emissions from the individual sources are estimated based on emission factors (24) for each of the sources and on operating information. EPA has rated these emission factors, depending on their accuracy, as A through E. An emission factor rating of A for a source implies that the emission factor is based on measured emissions data, process data, and engineering analysis. Thus, little uncertainty is associated with estimating emissions for a source which has emission factor rating of A. A rating of E implies very little data exists for the particular emission factor, and estimation of emissions based on such a factor is subject to a large error. Other information such as process weights, load factors, capacities, etc., required in addition to the emission factors for the estimation of emissions may have some associated inherent errors. Thus, even though emission data from NEDS represent the best available data in terms of completeness and quality of data, it will rank poorer than that of the census of population.

Meteorological data scores poorer on the uncertainty scale,

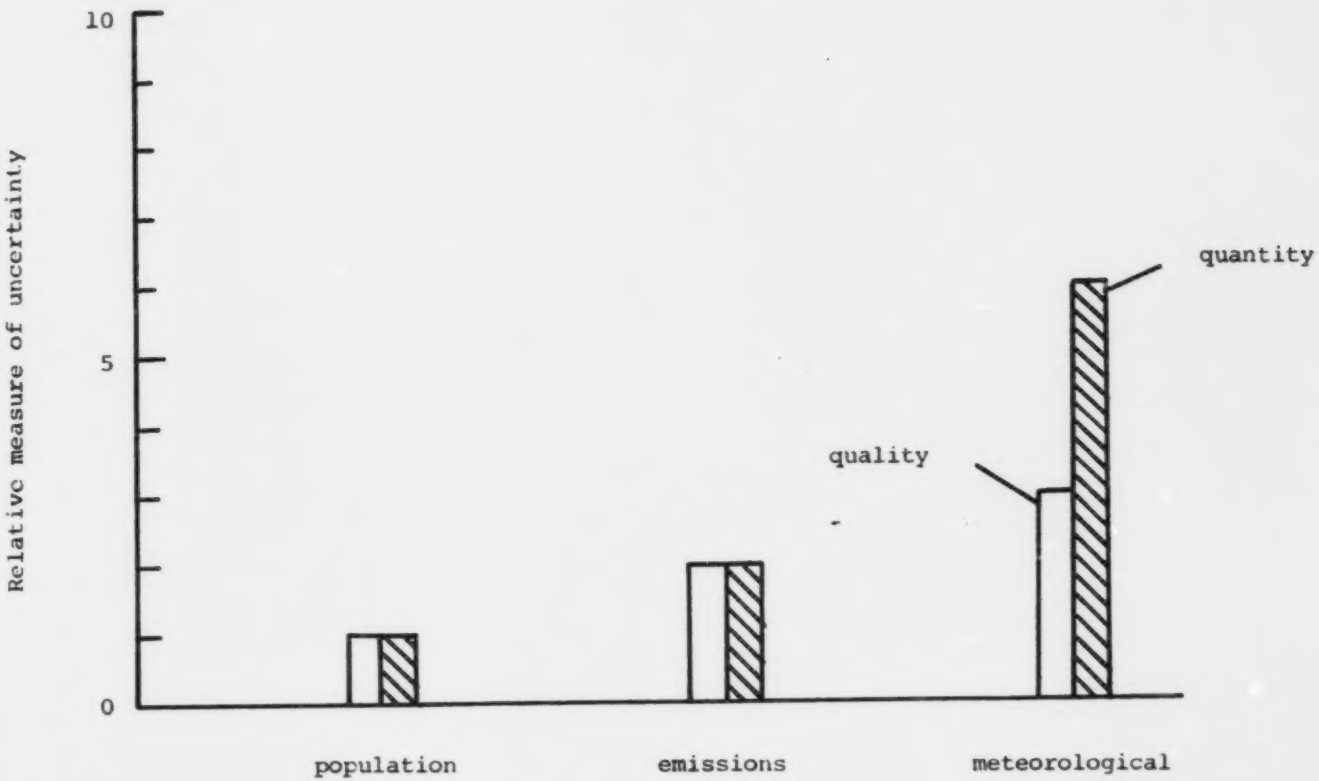

Figure 3. Representation of relative uncertainty in data bases.

especially in terms of "quantity" (Figure 3). For many years, the National Weather Service has maintained a network of continuously operating weather stations. Similarly, many of the air quality monitoring stations also monitor certain meteorological parameters. However, there are a very limited number of such stations in any single region. Thus, although good temporal (i.e., time varying) data are available for a particular site, there is certainly a lack of spatial meteorological data for predictive dispersion modeling.

Analysis

"Extent of known" for the processes and the data-bases discussed above can be estimated from the following expression:

$$\text{Extent known} \propto \frac{1}{\text{uncertainty}}$$

This expression is used to transform uncertainty ratings in Figures 2 and 3 to "extent known" in Figure 4. From Figure 4 it can be inferred that even if good data are available on population, considerations of source-receptor geometry limit the extent to which population data could be used. Similarly, lack of spatial meteorological data as well as of photochemical mechanisms governs how precise a dispersion model can be constructed. Finally, health effects, which are the least known consideration in the model, put a constraint on modeling of all the other processes as well as the use of the data bases. Thus, an efficient and useful model could be relatively simple in nature and attain the accuracy or validity contained by the uncertainty in health-effects data.

Specific parameters and mathematical relations for the construction

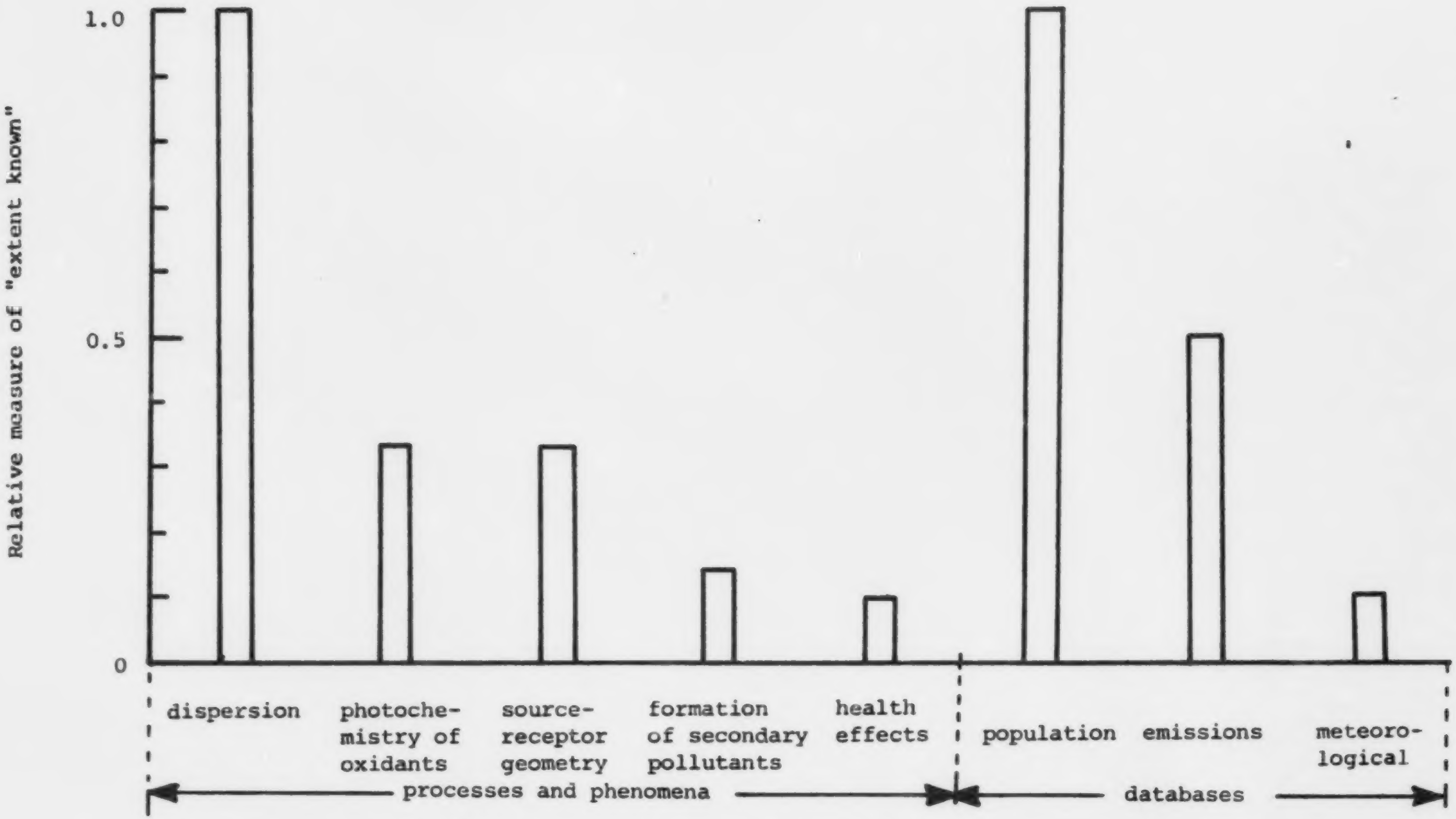

Figure 4. Representation of relative extent of knowledge of processes, phenomena and databases associated with the air quality management system.

of the model are discussed in the following section.

RATIONALE

As discussed in the previous sections, there is a large degree of uncertainty associated with most of the mathematical or empirical relationships among the parameters for relating emission to effects. The underlying rationale in construction was that the relations used in the models should be only as complex as warranted and undue complexity should be avoided. Availability of adequate input data was also an important constraint in modeling.

Selecting an appropriate time-base for the model is important for the balance of degree of details. Selecting a time-base means to decide whether the model should estimate hourly, daily, weekly, or annual exposures or whether the model should be dynamic, i.e., time-varying, in nature. The time-base would depend on availability of data for time-implicit parameters and empirical relations as well as their projected use in the model.

Rates of emissions are available only in terms of annual emissions or in tons per year. Logically, the data on air pollutant emissions forms a basis for a system or a model for priority-ranking of sources. Thus, even if data for other parameters, including meteorological, are available for a much finer time-basis, such as hourly or daily, etc., the annual or yearly basis for the model appears to be more practical.

Table I lists some of the many parameters that could be included in the model. It shows for each of the parameters the type of data

TABLE I. PARAMETERS FOR EXPOSURE MODELING

Parameter	(1) Desirable form	(2) Availability of (1)	(3) Form used in the model
(a) Emissions			
Sources	Individual	Yes	Individual
Types of pollutants	Five	Yes	Five
Rate	Amount/hour	No	Tons/year
Stack height	Actual	Yes	Actual
Plume height	Actual	No	Zero
(b) Meteorology			
Diffusivity	In the three orthogonal directions	No	σ_y σ_z[1] for a single stability C defined by Turner (25)
Wind data	Hourly windspeed and directional data for several locations	No	Symmetrical wind rose
(c) Source-Receptor geometry			
Population	Census tract	Yes	County, ring of average exposures[2]
Source locations	x, y coordinates	Yes	County centers[2]
(d) Atmospheric chemistry related to oxidant formation			
Reaction mechanism	Detailed mechanism of formation and decay	Partial	Equimolar NO_2 and HC stochiometric time-independent relation[3]
Rate constants	All required rate constants	Partial	Not used
Hydrocarbon emissions	HC emissions with reactivity classifications	No	Total hydrocarbons
(e) Health effects			
Dose-response	Generalized dose-response curves	No	Tolerance factors

TABLE I. PARAMETERS FOR EXPOSURE MODELING (CONTINUED)

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[1] σ_y σ_z are the standard deviations of distribution of pollutant concentrations in a plume.

[2] See Chapter V on the development of population submodel.

[3] See discussion of photochemical considerations in Chapter VI.

that would be desirable for precise modeling as well as whether such data are commonly available (Column 1 and 2 in Table I). Column 3 of Table I shows the form of the parameters that were included in the model. An explanation for selection of parameters follows.

SELECTION OF PARAMETERS AND DESCRIPTION

This population-pollution exposure model is called popex for short. It includes factors related to source emissions, meteorological dispersion, population distribution, and pollutant toxicity. The geographic area used in the model is the Chicago Air Quality Control Region (AQCR) but the model could be readily adapted to any other region. Reasons for the selection of the Chicago AQCR are given later in this chapter.

Emissions

Sources are treated individually in the model. In order to present results in terms of priority rankings, the pollution-population-exposure contributions for these sources are grouped into approapriate source categories. (Single sources at specific sites are referred to as "sources", and "source-categories" refer to predetermined categories of these sources. See Chapter VII for details.) The emission inventory of five pollutants supplied by the National Emissions Data System (NEDS) of EPA is used. Actual stack height for each of the sources is used. It would have been desirable to include plume height, however, no data for estimation of plume rise were available.

Meteorology

Comprehensive spatial meteorological data are generally unavailable.

To circumvent this lack of data, some simplifying assumptions were made. First, a single windspeed, an annual average, is used for all sources. Similarly, a symmetric wind rose is assumed. Next, a single class of stability, C, as defined by Turner (25) is used.

The basis for the assumption of a symmetric wind rose is discussed in the section on dispersion submodels. Other assumptions, along with the sensitivities of various meteorological parameters, are evaluated in Chapter IX.

Source-Receptor Geometry

Ideally each of the source locations and their effects on each of the population-receptors should be considered. However, due to size considerations, the computer model would become unmanageable. Some simplifying assumptions were necessary. In popex, all the sources have been located at the center of each county and the population is assumed to be uniformly distributed. This representation implies, as in reality, that some of the people are located much nearer to sources, whereas the majority of them are located at some distance away from sources. The mathematical model which was developed for such a situation is described in Chapter V.

Photochemistry of Oxidant Formation

The exact mechanism of formation of oxidant is still not known. More importantly, the emission inventory for one of the precursors of oxidant, namely reactive hydrocarbons, is not available. In popex a simple equimolar stochiometric reaction equation is used for estimation of formation of oxidant.

Health Effects

Modeling of health effects requires knowledge of cause-effect relationships. These empirical relations may be in the form of an increased incidence of certain disease as a function of air pollution dosages or in terms of the effect of air pollution as measured by certain clinical indicators. No such generalized air pollution-health-effect relationships were available at the beginning of this project in September 1973. Air quality standards which are based on health effects of pollutants can form the basis for health-effect modeling. Popex uses extrapolated air quality standards or tolerance factors. The detailed method is given in Chapter VI.

Selection of the AQCR

The United States has been divided into 247 AQCRs by EPA. There are many reasons for the selection of the Chicago AQCR for the popex model (Figure 5). Popex model for the ranking of sources includes considerations of source emissions as well as those of population receptors. Thus, the AQCR selected for modeling should not only have sources that are representative of nationwide air pollutant emissions but also should include counties which are significantly different from each other in their population densities.

Emissions.-Emissions from sources in the Chicago AQCR are generally quite well representative of the nationwide emissions. Table II compares emission data for the United States and for the Chicago AQCR (26). The emissions are given in terms of percentages of the total for each of the two cases. There are some differences in the percent emissions of Chicago

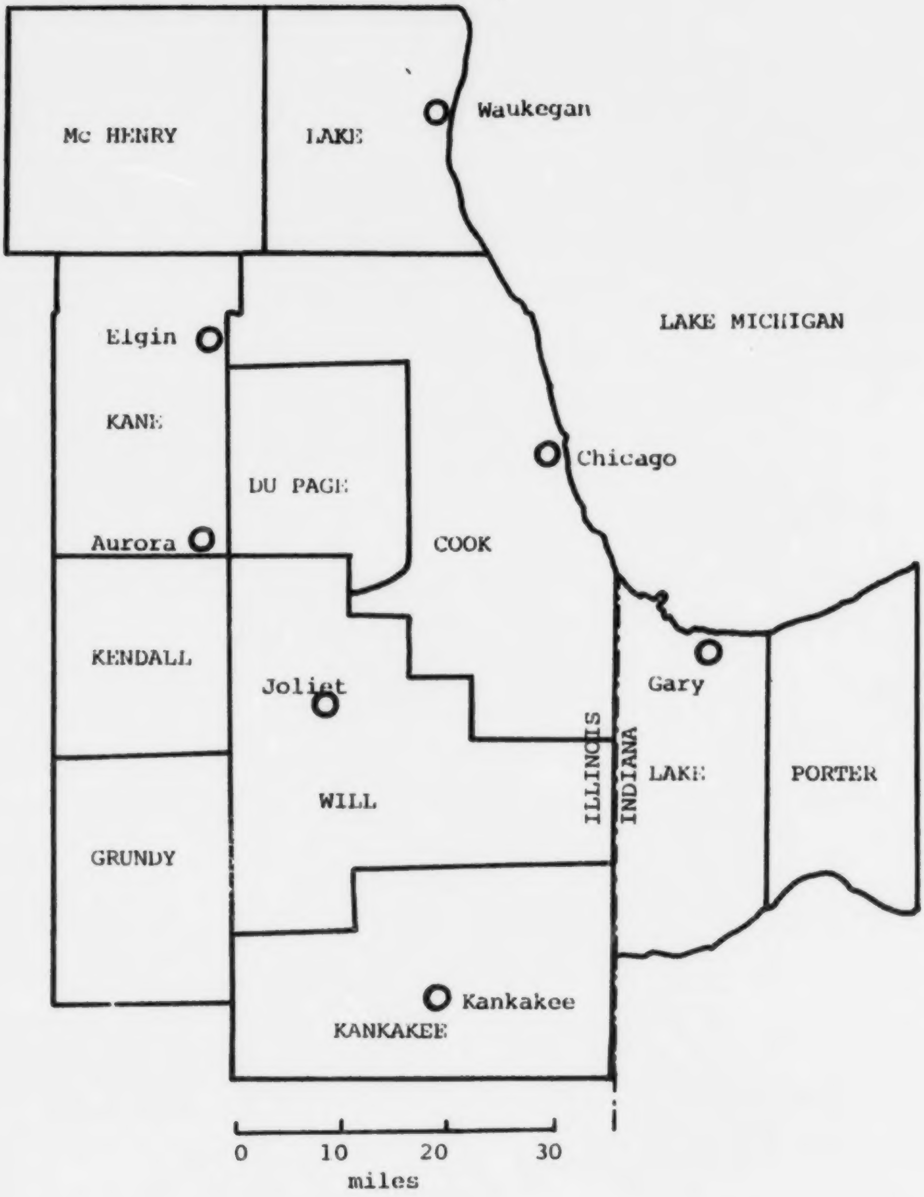
Mc HENRY
LAKE
Waukegan
LAKE MICHIGAN
Elgin
KANE
DU PAGE
Chicago
Aurora
COOK
KENDALL
Joliet
Gary
ILLINOIS
INDIANA
LAKE
PORTER
WILL
GRUNDY
Kankakee
KANKAKEE
0
10
20
30
miles

Figure 5. Map of the Chicago air quality control region (AQCR number 67, Illinois-Indiana).

TABLE II. COMPARISON OF UNITED STATES AND CHICAGO AQCR EMISSIONS

Categories	Emissions	
	U.S. as percent of the total (202,567,000 tons/year)	Chicago AQCR as percent of the total (7,477,000 tons/year)
Fuel combustion		
External combustion		
Residential fuel - area	1.1	2.7
Electric generation - point	13.3	8.4
Industrial fuel - area	1.8	3.6
- point	4.7	17.4
Commercial-institutional - area	1.1	0.8
- point	0.2	0.3
Internal combustion - point		
Electric generation	0.03	nl[1]
Industrial fuel	0.5	nl
Commercial-institutional	0.001	nl
Engine-testing	0.001	nl
Industrial process - point		
Chemical manufacturing	4.7	0.5
Food/agriculture	0.2	0.1
Primary metals	4.7	6.3
Secondary metals	0.9	0.6
Mineral products	2.9	2.1
Petroleum industry	5.4	8.7
Wood products	0.7	0.0001
Evaporation	1.4	2.3
Metal fabrication	0.003	0.01
Leather products	0.0002	nl

TABLE II. COMPARISON OF UNITED STATES AND CHICAGO AQCR EMISSIONS (CONTINUED)

Categories	Emissions	
	U.S. as percent of the total (202,567,000 tons/year	Chicago AQCR as percent of the total (7,477,000 tons/year)[1]
Industrial process - point continued		
Textile manufacturing	0.004	nl
Inprocess fuel	0.1	0.007
Other/not classified	0.1	0.1
Solid waste disposal		
Government - point	0.2	0.4
Residential - area	2.1	1.4
Commercial-institutional - area	0.2	0.2
- point	0.01	0.1
Industrial - area	0.9	2.8
- point	0.5	0.2
Transportation - area		
Land vehicles		
Gasoline	47.2	36.0
Diesel fuel	1.8	1.5
Aircraft	1.0	0.5
Vessels	0.4	0.1
Gas handling evaporation loss	0.5	0.4
Miscellaneous - area		
Slash burning	0.5	nl
Solvent evaporation loss	0.8	2.5
Total	100.0	100.0

[1] nl = none listed

AQCR as compared to the nationwide numbers, but, generally, there is a good agreement in the percent emissions for the same categories. The two categories that are relatively large by themselves as well as the categories for which there are large differences are fuel-combustion-industrial-point (U.S., 4.7; Chicago, 17.4) and industrial-process-chemical manufacturing (U.S., 4.5; Chicago, 0.5). The large difference in the industrial fuel category is primarily due to an error[1] in the emissions of a single source. After correcting for the error, the percent emissions of the industrial fuel category for Chicago AQCR is 5.3 which is comparable to 4.7 for the U.S. All the emissions data reported subsequent to Table II and used in this research includes this correction.

It appears that industries involving the manufacture of chemicals are less in number in the Chicago area. Thus, in this case, the results of the popex model which is applied to Chicago AQCR data would tend to underestimate the nationwide importance of emissions from chemical industries.

Some of the source-categories appearing on national emissions data such as internal combustion, slash burning, industries involving wood, leather, and textile products, etc., are virtually nonexistent in the

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[1] After examining the detailed emissions data referred to in the section on input data (Chapter VII), it was found that a single source using process gas located in Lake County in Indiana had unusually large emissions (about 350 times the emissions of similar sources of equal capacities). In fact the NO_x emissions of this single source were 789,000 tons per year or about 60 percent of the total emissions of 1,348,000 tons per year for the entire Chicago AQCR. This apparent error was corrected by using average values of emissions of similar sources in the same county. This correction also agrees with the more recently obtained emission totals for the eleven counties from NEDS.

Chicago area. However, emissions from these categories represent less than 2 percent of the national emissions on a mass basis. Consequently, these categories would be relatively unimportant even if they were present in the Chicago area.

An additional point in favor of the selection of the Chicago AQCR was that it was one of the few AQCRs for which nearly complete emissions data were available at the start of this project in September 1973.

Population.-Counties included in Chicago AQCR range from the densely populated urban area of Cook County (5753 people/square mile) to the sparsely populated rural area of Grundy County (61 people/square mile). Population densities of the remaining nine counties lie between these two extremes (Table III). Heavily industrialized counties include Cook and Will in Illinois and Lake in Indiana. It is interesting to note that two (Cook and Will) of the three also are almost at the two extremes of the population density scale.

FLOW DIAGRAM

A flow diagram for popex is given in Figure 6. The emissions of different pollutants are weighted by their tolerance factors which are based on ambient air quality standards, and are combined into one number (see Chapter VI for more details). The concentrations of the combined emissions reaching the receptors are estimated using the dispersion model whose construction is described in Chapter IV.

In calculating inter-county population exposures, county population has been assumed to be concentrated at the center of its respective

TABLE III DEMOGRAPHIC DATA FOR CHICAGO AQCR(27)

County	State	Population	Area, sq. miles	Density (people/ sq. miles)
Cook	Illinois	5,488,328	954	5,753
DuPage	Illinois	491,882	331	1,486
Grundy	Illinois	26,535	432	61
Kane	Illinois	251,005	520	483
Kankakee	Illinois	97,250	678	143
Kendall	Illinois	26,374	320	82
Lake	Illinois	382,638	457	837
McHenry	Illinois	111,555	610	183
Will	Illinois	249,498	847	295
Lake	Indiana	546,253	513	1,065
Porter	Indiana	87,114	425	205
Chicago	AQCR	7,758,432	6,087	1,275

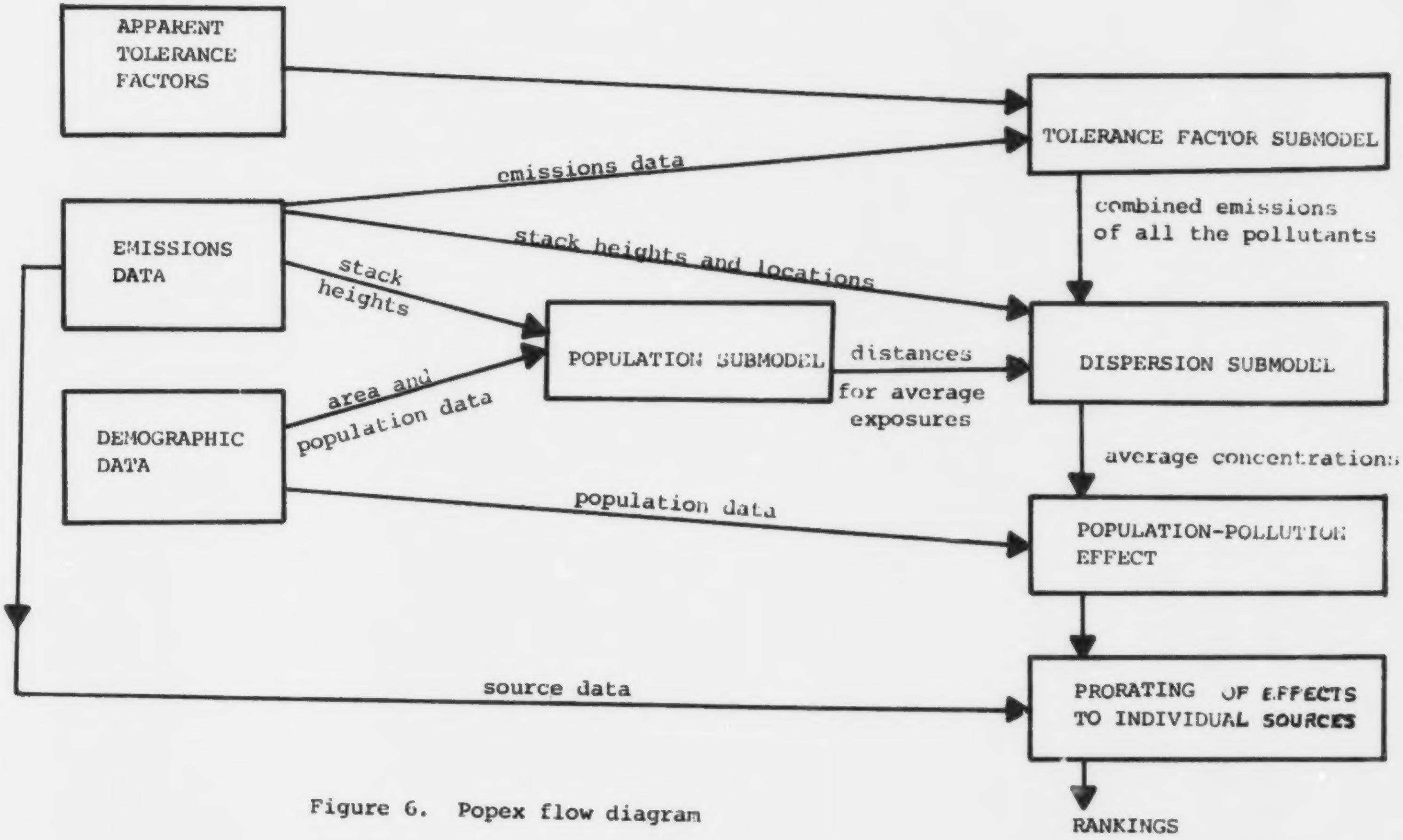
APPARENT TOLERANCE FACTORS
EMISSIONS DATA
DEMOGRAPHIC DATA
emissions data
stack heights and locations
stack heights
area and population data
population data
source data
TOLERANCE FACTOR SUBMODEL
combined emissions of all the pollutants
POPULATION SUBMODEL
distances for average exposures
DISPERSION SUBMODEL
average concentrations
POPULATION-POLLUTION EFFECT
PRORATING OF EFFECTS TO INDIVIDUAL SOURCES
RANKINGS

Figure 6. Popex flow diagram

county. The concentrations of pollutants at these receptor locations in each county are calculated for all the sources from all the other counties. The extent of population exposure is determined by weighting the receptor-point concentration proportional to the population of the receptor county.

In the case of self or intra-county pollution (the pollution emitted by a county affecting people in the same county), computation of pollution-population exposure is more complex. A submodel was developed which estimates a ring of average exposure for each source for subsequent calculation of average exposure to the population in the county. Details of this population submodel are given in Chapter V.

Finally, the intra-county and inter-county exposures are summed for all counties in the AQCR. The pollution-population exposure due to all the sources in all the counties of the AQCR is then summed. The percent contribution of each individual source to the total pollution-population exposure is then back-calculated and is used for assigning a priority-ranking for each source category.

DEVELOPMENT OF SUBMODELS

As discussed earlier, considerations of dispersion, exposure to people and subsequent health effects of the air pollutants are included in the popex model for ranking of sources. Each of these three areas form submodels. Submodels for dispersion, population exposure, and health effects are discussed in the following three chapters. For each of the submodels, a generalized discussion along with a review of pertinent literature is given first, followed by a detailed description of rationale, development and construction of the submodel.

CHAPTER IV

DISPERSION SUBMODEL

INTRODUCTION

There are two basic types of dispersion models: steady state models (box and plume models) and unsteady state models, or models which have time as one of the variables (puff model). The box model is the simplest and assumed to be a rectangular covered box with defined dimensions (28). The height of the box is the mixing depth of the atmosphere, or the height of the unstable layer in the atmosphere, in which pollutants can disperse. The flow of air is assumed to be in one end of the box and out the other. The concentration in this "box" is given by:

$$C = q_o + \frac{Q}{D \times H \times U} \qquad (1)$$

where C is the concentration of air pollutant, $\mu g/m^3$

q_o is the concentration of background air pollution, $\mu g/m^3$

Q is the emissions, g/sec

D and H are the width and the height of the box, km

and U is the windspeed, m/sec.

The sources within the box are modeled as a completely-mixed and dispersed area source.

Gaussian plume models (18) have been developed as a more realistic representation of dispersion (Figure 7). With the plume model, an individual characterization of each source is possible. The concentration, C, at any downstream point (x, y, z) can be calculated from the following equation:

$$C = \frac{Q}{2\pi\sigma_y\sigma_z U} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \cdot \left(\exp\left[-\frac{1}{2}\left(\frac{z-h}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{z+h}{\sigma_z}\right)^2\right]\right) \quad (2)$$

where x = distance downwind in the direction of wind, km

y = crosswind distance, km

z = height above ground level, km

h = effective source height above the ground surface, km

σ_y, σ_z = the standard deviations of the plume concentration distribution in the crosswind direction and in the vertical direction, respectively, km.

The total concentration at a receptor point is the sum of the contribution from all the sources plus background concentration. In a sophisticated puff model time variables are included and a simulated puff can be made to react to altered weather conditions downwind from a source (29).

The results obtained from any dispersion model are completely dependent upon the quality or reality of the input data. Utilization of a complex and time-consuming meteorological model in popex could have increased the sophistication of the methodology. However, in order to balance the levels of complexities and accuracies with other

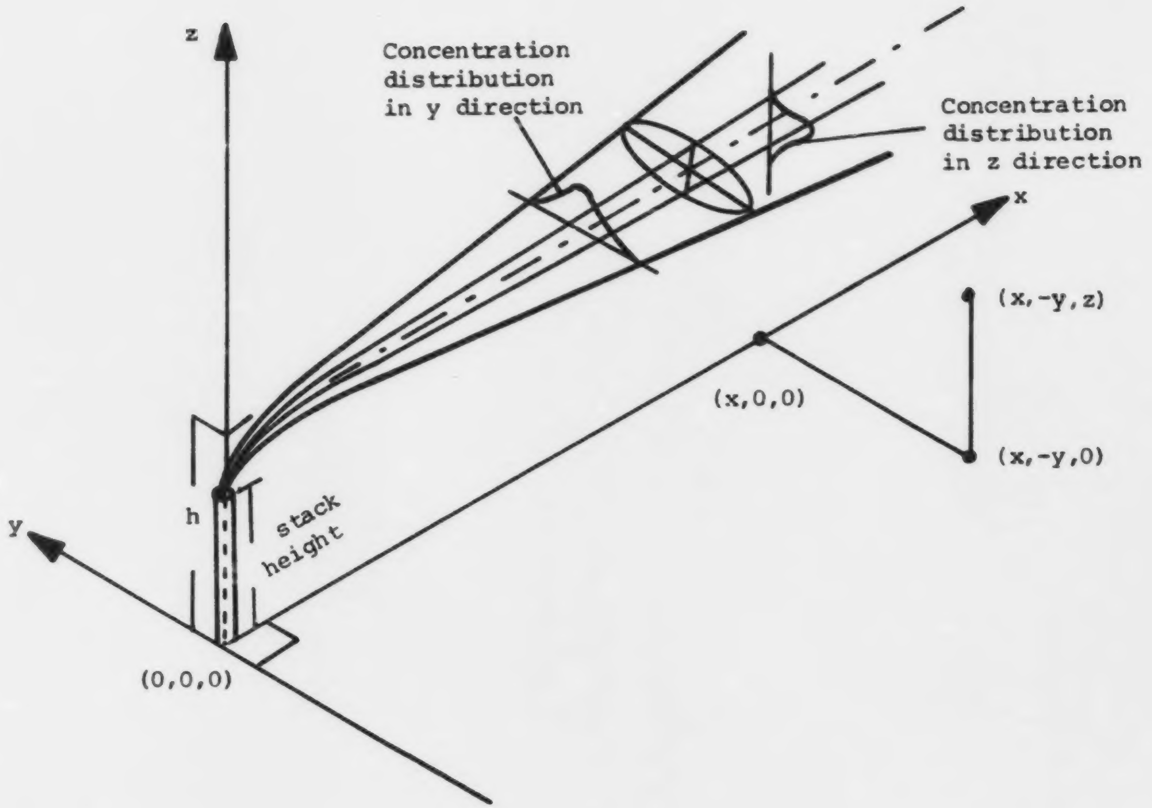
z
Concentration
distribution
in y direction
Concentration
distribution
in z direction
x
(x,-y,z)
(x,0,0)
(x,-y,0)
y
h
stack
height
(0,0,0)

Figure 7: Plume model

aspects of the methodology, a simpler meteorological model which has a level of sophistication beyond that of a box model was constructed.

DEVELOPMENT

A simple dispersion model, based on the Gaussian plume equation 2 was developed for estimating long term average concentrations in concentric rings surrounding each emission point. Stack height and distances from a source have been retained as variables, while most meteorological conditions were held constant.

This submodel differes form other plume models such as the Air Quality Display Model (AQDM) in one important aspect: the submodel assumes a symmetrical wind rose, or that the wind blows from each direction for an equal fraction of time. The bases for this assumption are discussed in the following section.

The assumption of symmetric wind rose also allows for a simplification of the overall dispersion algorithm. In this submodel, a set of empirical expressions were developed which are used in conjunction with equation 2. The actual procedure for the development and use of the submodel is discussed later in this chapter.

Rationale for Assumption of Symmetric Wind Rose

The considerations that prompted the assumption of symmetric wind rose were: (a) A detailed temporal wind rose data for one or two locations within as AQCR can not adequately represent the wind rose data for the AQCR. Different locations within the AQCR may have different wind roses, especially if the AQCR is located adjacent to an ocean or a lake. Such spatial wind rose data are not available.

(b) There are variations in the wind rose with seasons. Even if the wind rose for a particular season is assymmetrical, the annual averages, especially the data averaged for different altitudes, may be quite symmetrical.

Lake Michigan has considerable influence on the meteorology of the Chicago AQCR. Day-time heating of land surfaces, especially during the warm seasons, either strengthens the onshore flow of winds (lake breeze), weakens the offshore flow, or produces an onshore flow that would not otherwise exist (30). The lake breeze can cause the winds to blow in two different directions at two locations, one near the lake shore and the other several miles inland, but both within the AQCR. At certain times during spring and summer months the location nearer the lake shore will have winds from the lake and the inland location may have winds governed by macroscale meteorology. Similarly, the lake causes substantial recirculation of air. All of these points related to the assumption of a symmetric wind rose are discussed below.

In the Chicago area windspeed and wind direction data from the two National Weather Service (NWS) stations located at Midway (MDW) and O'Hare (ORD) airports are published regularly (31). The average resultant annual windspeeds and directions for 1973 and 1974 for both of these stations are shown in Table IV.

TABLE IV. ANNUAL RESULTANT WINDSPEEDS AND DIRECTIONS FOR CHICAGO

	Midway Airport		O'Hare Airport	
Year	Wind direction	Wind speed (mph)	Wind direction	Wind speed (mph)
1973	210[1]	1.6	230	1.8
1974	210	2.0	240	2.3

[1] Figures for wind directions are in degrees from North, i.e., 90 - East, 180 - South, 270 - West, 360 - North.

The wind directions are essentially the same for these two locations. However, as the Figure 8 shows, these airport locations are inland (MDW is 9 miles from the nearest lake shore and ORD is 14 miles). The wind data from other locations (Figure 8) such as Meigs Airfield (CGX), DuPage County Airport (DPA), and Glenview Naval Air Station (NBU) are not published and are kept on NWS files for only 90 days. Even these locations, as Figure 8 shows, may not adequately represent the outlying counties.

The data for two periods (June 5-7 and July 26-29, 1975) for these airport locations were obtained by copying the hourly datalogs[2] kept at the NWS office, 1749 West Pershing Road in Chicago. The weather conditions during these two periods were varied and included days with (a) average windspeeds of 10-15 mph or moderate-to-

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[2] Generally only data for 9 a.m. to 9 p.m. were available for all of the five stations. CGX remains closed from 11 p.m. to 5 a.m. and on most days no data was available from NBU between 9 p.m. and 9 a.m.

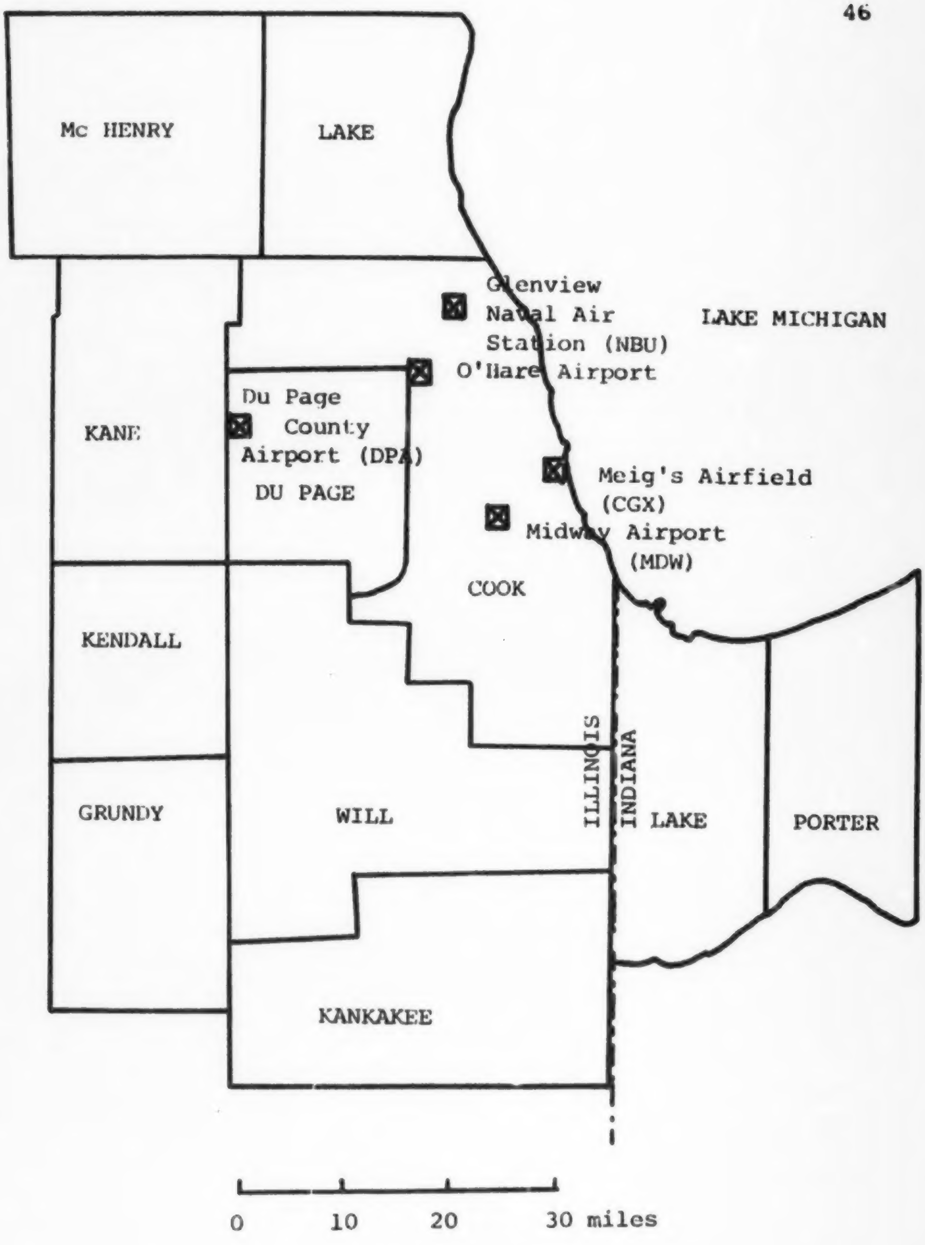
Mc HENRY
LAKE
Glenview
Naval Air
Station (NBU)
LAKE MICHIGAN
O'Hare Airport
Du Page
County
Airport (DPA)
KANE
DU PAGE
Meig's Airfield
(CGX)
Midway Airport
(MDW)
COOK
KENDALL
ILLINOIS
INDIANA
GRUNDY
WILL
LAKE
PORTER
KANKAKEE
0
10
20
30 miles

Figure 8. Airport locations in Chicago AQCR for wind data.

strong winds with no lake breeze (June 5 and 6) and with lake breeze (July 27), (b) average windspeeds of 7-9 mph or moderate winds with no lake breeze (June 7 and July 26), (c) average windspeeds of 4-6 mph or moderate-to-light winds with lake effect (July 28 and 29).

On a day when the inland and near shore temperatures are the same (difference of less than 3 to 4°F) or no lake-effect and when strong winds are present, the wind roses for different locations are quite similar (Figure 9). Even then there are some differences; MDW has predominantly NW[3] and ORD has predominantly W winds. The variability in the wind roses increases when the windspeeds are lower (<10 mph) as shown in Figure 10. In cases when there is a lake breeze, due to the inland area being warmer than the lake water, wind roses at different locations are significantly different (Figures 11 and 12). In Figure 11, on a day with a light lake breeze the location near the shore (CGX and NBU) has E winds whereas other inland stations have winds from S and SE. Figure 12 shows a day (July 27) with stronger lake effects.

To visualize the changes in wind directions for the day with a strong lake effect (July 27), the wind directions at three hour intervals are depicted on Figure 13. At 6 a.m. all stations except DPA have winds from SW and DPA has W winds. W to NW winds predominate at all the locations at 9 a.m. At 12 noon for CGX there is a change in

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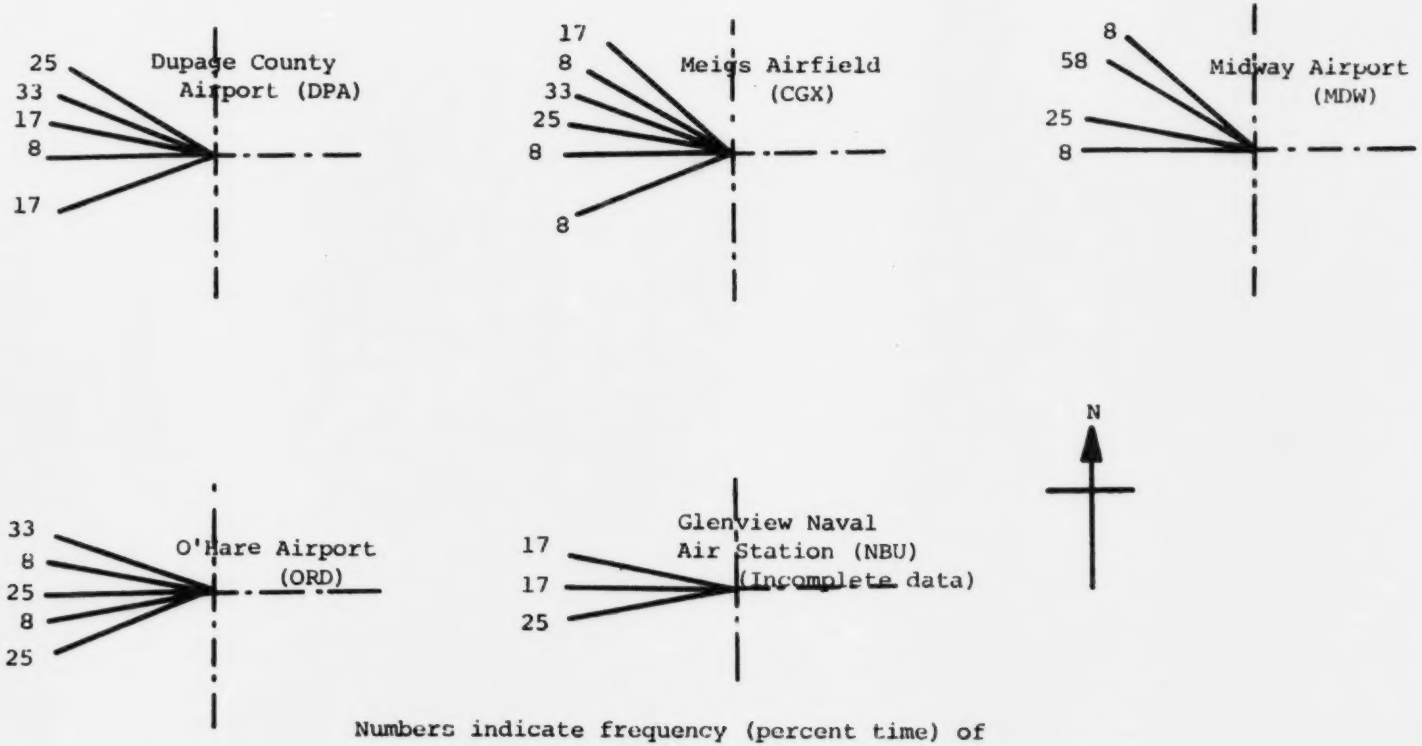
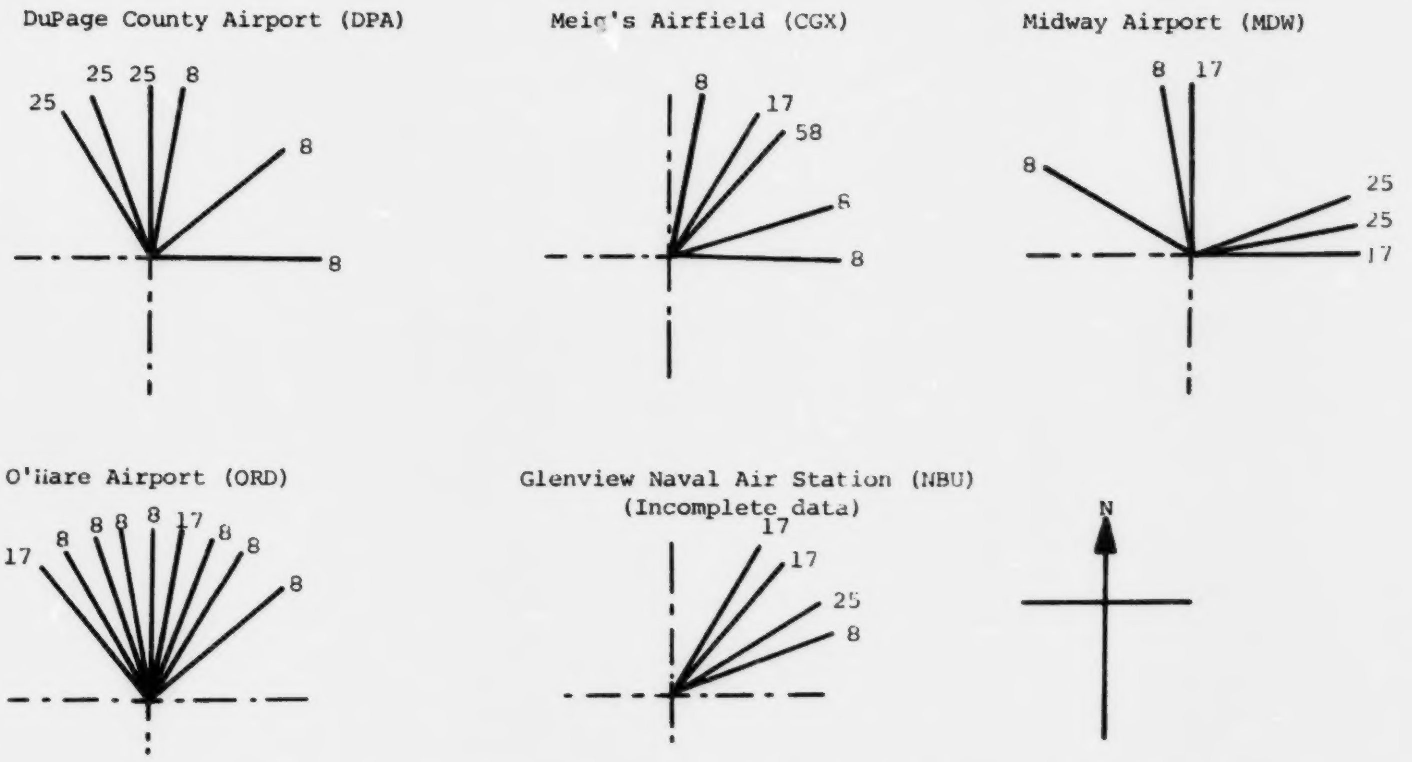
[3] Wind directions: E - east, SE - southeast, S- south, SW - southwest, W - west, NW - northwest, N- north, NE - northeast.



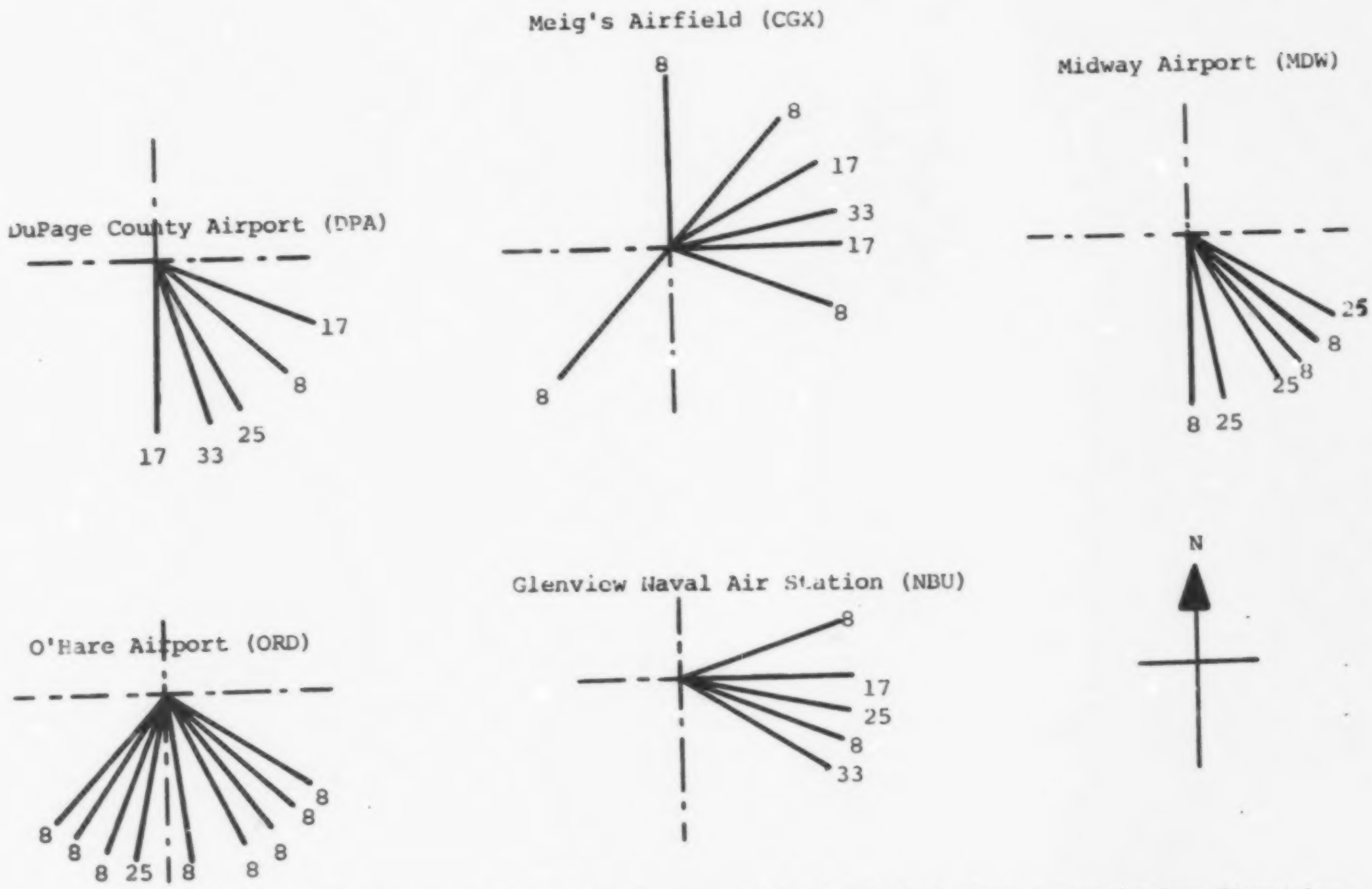
Numbers indicate frequency (percent time) of wind from a particular direction

Figure 9. Wind roses for different locations in Chicago AQCR for June 5, 1975 (9 am to 9 pm).



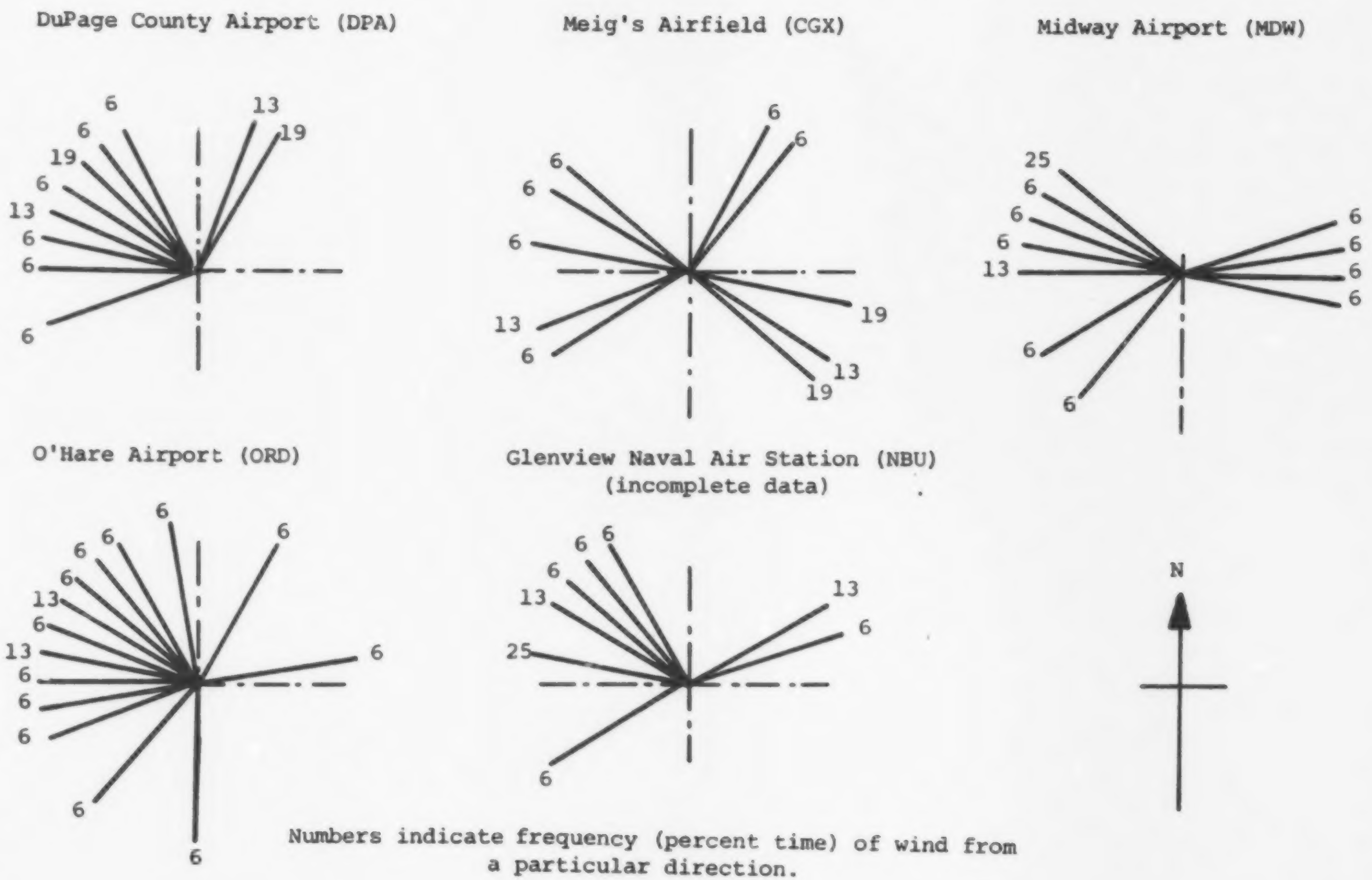
Numbers indicate frequency (percent time) of wind from a particular direction.

Figure 10. Wind roses for different locations in Chicago AQCR for June 7, 1975. (9 am to 9 pm).



Numbers indicate frequency (percent time) of wind from a particular direction.

Figure 11. Wind roses for different locations in Chicago AQCR for July 29, 1975 (9 am to 9 pm).



Numbers indicate frequency (percent time) of wind from a particular direction.

Figure 12. Wind roses for different locations in Chicago AQCR for July 27, 1975 (6 am to 9 pm).

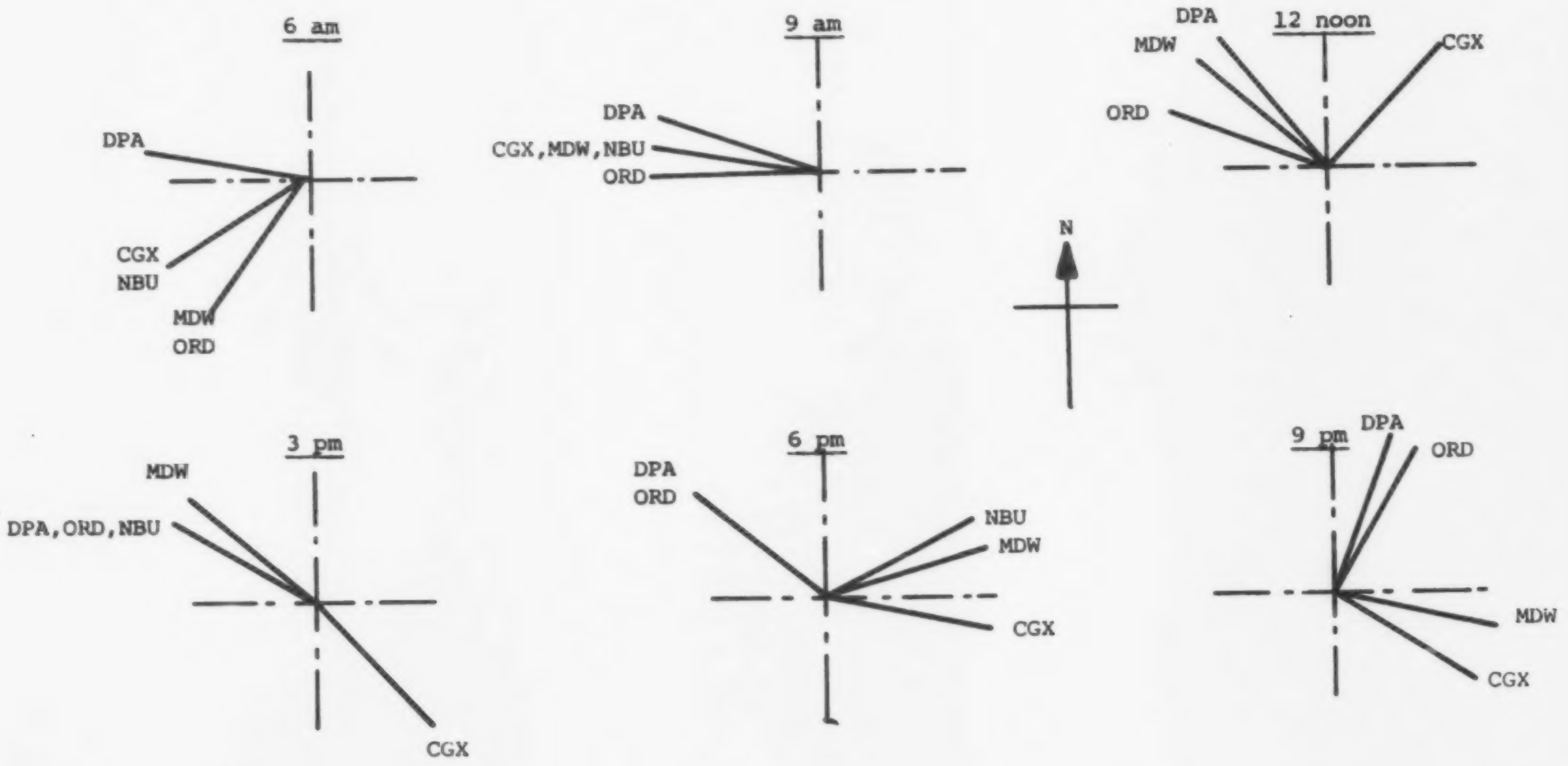

6 am
DPA
CGX
NBU
MDW
ORD
9 am
DPA
CGX,MDW,NBU
ORD
12 noon
DPA
MDW
ORD
CGX
N
3 pm
MDW
DPA,ORD,NBU
CGX
6 pm
DPA
ORD
NBU
MDW
CGX
9 pm
DPA
ORD
MDW
CGX

Figure 13. Wind directions at three-hour intervals for different locations in Chicago AQCR on July 27, 1975.

wind direction by almost 90 degrees and its wind direction becomes NE. This shows the start of the lake breeze. At 3 p.m. CGX has SE winds but all other locations still show NW winds. At 6 p.m., wind direction at both MDW and NBU, in addition to CGX, become essentially E, and DPA and ORD still show NW. Note that MDW and NBU are nearer the lake than DPA and ORD and, hence, the lake breeze from E affects MDW and NBU first. At 9 p.m. DPA and ORD show N to NE winds, and CGX and MDW show E to SE. Finally, at midnight (not shown in Figure 13) all the reporting stations have W winds. Thus, in less than 24 hours winds have changed direction by almost 360°. Also, through a significant part of the day different stations had different wind directions. Such conditions could be experienced for 60 percent of spring and summer days or for a substantial fraction of the time during a year (28).

The lake also causes recirculation of air pollutants. In an experiment performed by Lyons and Olsson (32), balloons released into an onshore or lake breeze rose, went opposite to the lake breeze, then descended and returned in the onshore breeze, then started to repeat the cycle as indicated on Figure 14. This means that pollution can be blown away only to return, sometimes several times in the same day. The dispersion equations are not able to account for this occurrence.

Finally, for a given location, different seasons of the year may have different wind roses. Figure 15 shows wind rose data for a power plant located within the Chicago AQCR (33). Wind roses for each of the calendar quarters are shown in the four corners on Figure 15.

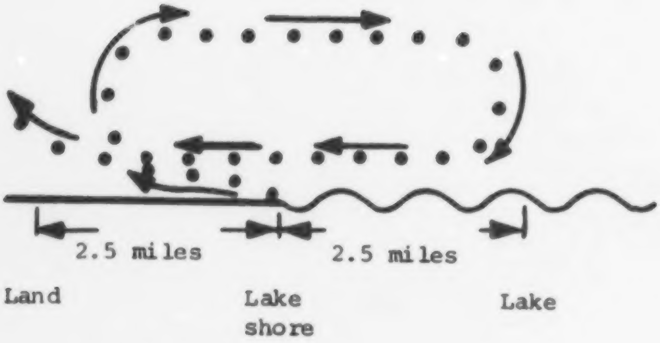

2.5 miles
2.5 miles
Land
Lake shore
Lake

Figure 14: Pollutant trajectory in a lake breeze, adapted from (32).

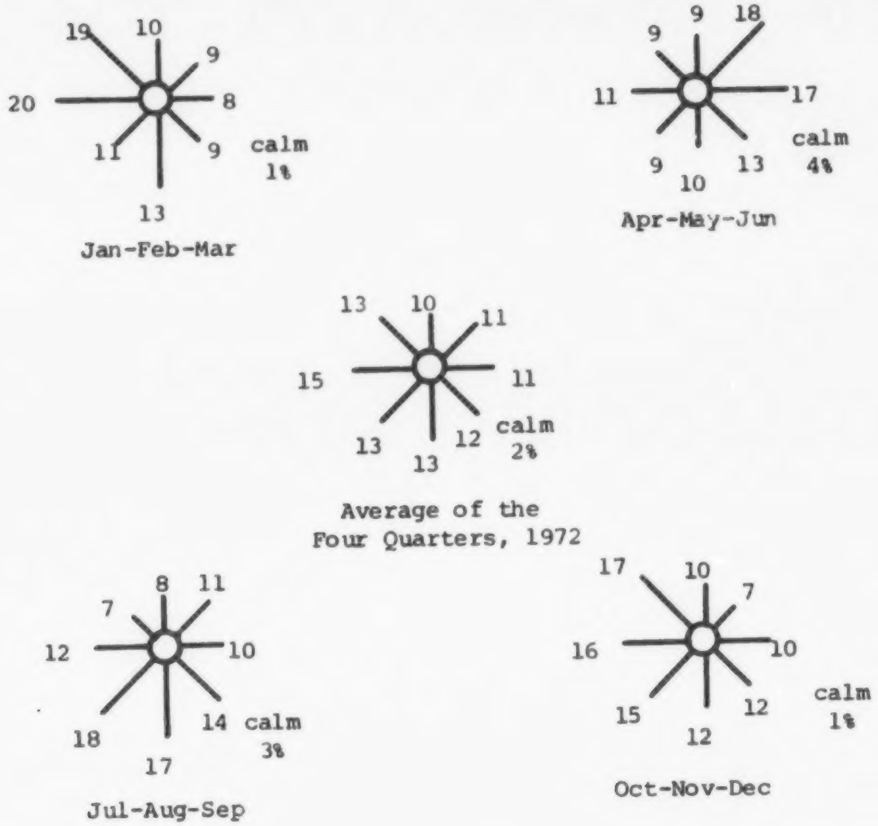


Figure 15: Wind rose data for Dresden nuclear power station of Commonwealth Edison Company, 1972 (33).

During the fall and winter months, winds are predominantly from W and NW. The NE and E winds dominate to some extent in the spring months, whereas during the summer, S and SW winds are more frequent. Of course, these particular data for the wind rose for a single location may not be truly representative of the whole AQCR. However, the average of wind roses (Figure 15, center) is remarkably symmetrical.

In summary, the reasons for assuming a symmetric wind were: (a) wind roses at a single location can not describe the conditions in the entire AQCR, and the data for other locations are not available in readily-obtainable published format, (b) an average of seasonal wind roses is noticeably symmetric.

Construction

The dispersion equation employed in this submodel for ground level concentration (z = 0 in Figure 7) is as follows:

$$C = \frac{Q}{U\sigma_y\sigma_z\pi} \cdot \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \cdot \exp\left[-\frac{1}{2}\left(\frac{h}{\sigma_z}\right)^2\right] \qquad (3)$$

and for stability C as defined by Turner (25):

$$\sigma_y = 0.1\ x^{0.92} \qquad (4)$$

$$\sigma_z = 0.06\ x^{0.9} \qquad (5)$$

where σ_y, σ_z and x are in km.

In this case, the plume rise above the stack was assumed to be zero and thus, h is the stack height. The concentration at any point x, y can be calculated using equation 3. This would vary depending on the wind direction, even if average windspeed and stability were held constant.

In order to get an estimate of average concentration at points which are equidistant from a source, the following method was developed based on a symmetric wind rose, which saves a considerable amount of computer time. The basic approach was to estimate an imaginary angle θ (where $x = r\text{Cos}\ \theta$ and $y = r\text{Sin}\ \theta$) such that the concentration $C(r,\theta)$ at the point (r,θ) is the average annual concentration, $\overline{C}(r)$, at any point at a distance of r from the source.

To obtain a generalized expression for θ, concentrations using equation 3 were determined for different values of θ with height of stack and r held constant. Next, the averages of these concentrations for different values of θ were computed. This average concentration would be the same as the average concentration with symmetrical wind rose for a point at a distance r from the source. The average concentration was matched against the values of $C(r,\theta)$ for different values of θ. This would give a θ' for a particular r' so that $C(r', \theta')$ would be the same as $\overline{C}(r')$. This process was repeated for different stack heights and distances up to 100 km. The angle, θ, was regressed (34) against the stack height and distance from this data. The methodology is given in Figure 16.

The following equation for θ was obtained which is applicable to all heights and distances above four kilometers. Table V gives a similar equations for the other conditions.

$$\theta = 14.24 - 0.79\ \ln(r) \text{ for } r > 4 \qquad (6)$$

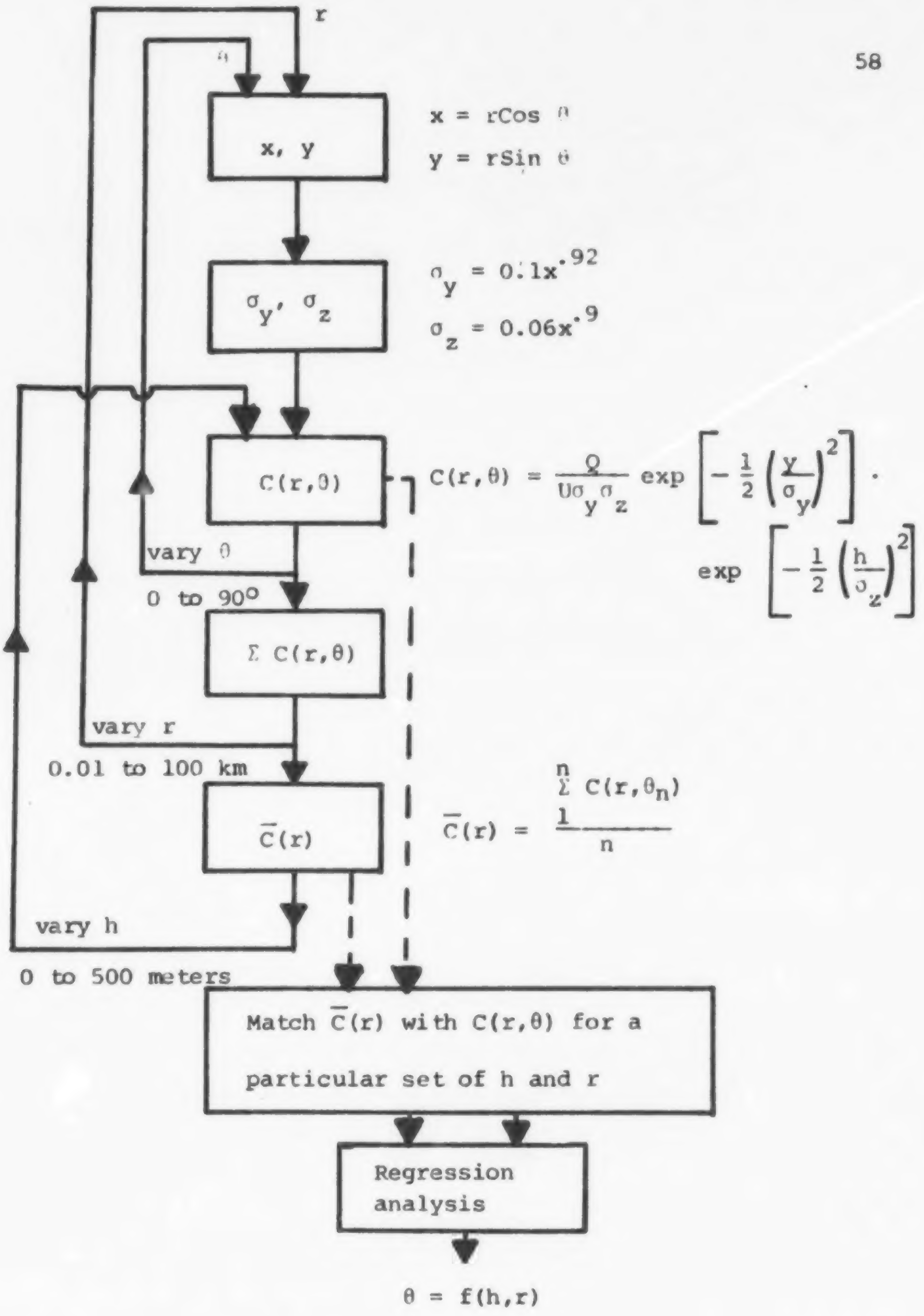

r
θ
x, y
x = rCos θ
y = rSin θ
σ_y, σ_z
$\sigma_y = 0.1x^{.92}$
$\sigma_z = 0.06x^{.9}$
C(r,θ)
$C(r,\theta) = \frac{Q}{U\sigma_y\sigma_z} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \cdot \exp\left[-\frac{1}{2}\left(\frac{h}{\sigma_z}\right)^2\right]$
vary θ
0 to 90°
Σ C(r,θ)
vary r
0.01 to 100 km
$\overline{C}(r)$
$\overline{C}(r) = \frac{\sum_1^n C(r,\theta_n)}{n}$
vary h
0 to 500 meters
Match $\overline{C}(r)$ with C(r,θ) for a particular set of h and r
Regression analysis
θ = f(h,r)

Figure 16: Flow diagram: development of dispersion submodel

TABLE V. EQUATIONS FOR ANGLE θ IN THE DISPERSION SUBMODEL

Equations	Limits	
	Height, h, in meters	Distance, r, in Km
$\theta = 14.24 - 0.79 \ln(r)$	$h<500$	$r>4$
$\theta = 14.28 - 0.79 \ln(r) - 0.01 r$	$100<h\leq500$	$1<r\leq4$
$\theta = 14.56 - 0.79 \ln(r) - 0.08 r$	$10<h\leq100$	$0.7<r\leq4$
$\theta = 15.04 - 0.79 \ln(r) - 0.5 r$	$h\leq10$	$0.2<r\leq1$

For this equation coefficient of determination,[4] R^2 is greater than 0.99.

Finally, in order to calculate a concentration at any location at a distance r from a source with a stack height equal to h, the equations 6, $x = r\mathrm{Cos}\ \theta$, $y = r\mathrm{Sin}\ \theta$, 4, 5 and 3 are used, in that order. The details of the computer algorithm are given in Chapter VII.

---

[4] The coefficient of determination R^2 is the proportionate reduction in the variation of the dependent variable θ, which is explained by the independent variable r.

CHAPTER V

POPULATION SUBMODEL

INTRODUCTION

The purpose of the submodel was to characterize spatial distributions of population and population characteristics with respect to sources of air pollution. There are a multitude of factors involved in the characterization of population and its distribution and inclusion of all the factors could make such modeling an exceedingly complex, if not an impossible task. People are not located at equal distances with respect to different sources or even similar sources of air pollution. Quite often people work in different places than they reside, which means that they are exposed to different levels of pollution in a single day. Similarly, depending on the mode of travel, they are exposed to more or less pollution. Thus, in a model which simulates these conditions, not only do the complex distributions have to be included but they have to be dynamic in nature or a time factor needs to be included. Inclusion of age and other factors in the people-location-time model would lead to further complications.

DEVELOPMENT

Rationale

In this first generation model only population and county area, with an assumption that population density is constant within a county, were considered. Even in this case, the modeling was not straight forward. Except in cases of very tall stacks, people living nearer to the industries obviously experience a larger pollution dose than those living at greater distances. It has not been feasible to determine the source-receptor damage for each location-specific inhabitant. Billions of computations would have been required (up to 1800 for each inhabitant, in the extreme). Moreover, extremely large amounts of needed computer storage could have made running and debugging a computer program very difficult.

The principle used to reduce the complexity of the model and computer time was to find a generalized expression for the distance between the source and a point such that the concentration at that point would be the same as the average concentration experienced by people for that particular source and county combination. Thus, the total number of computations of concentration would be equal to the total number of sources in the AQCR. These source-county specific-distances, called rings of average exposure, were derived in the following manner and the methodology is depicted in Figure 17.

Construction

A series of weighted average self-pollution concentrations for two county sizes (radii, 30 and 100 km) and for different stack heights (1 to 500 meters) were calculated. Next, for each case, the weighted average concentrations were matched against concentrations for the various distances derived earlier. The distances at which the two concentrations were equal were tabulated with the appropriate stack height and county area. The results for the distances or ring

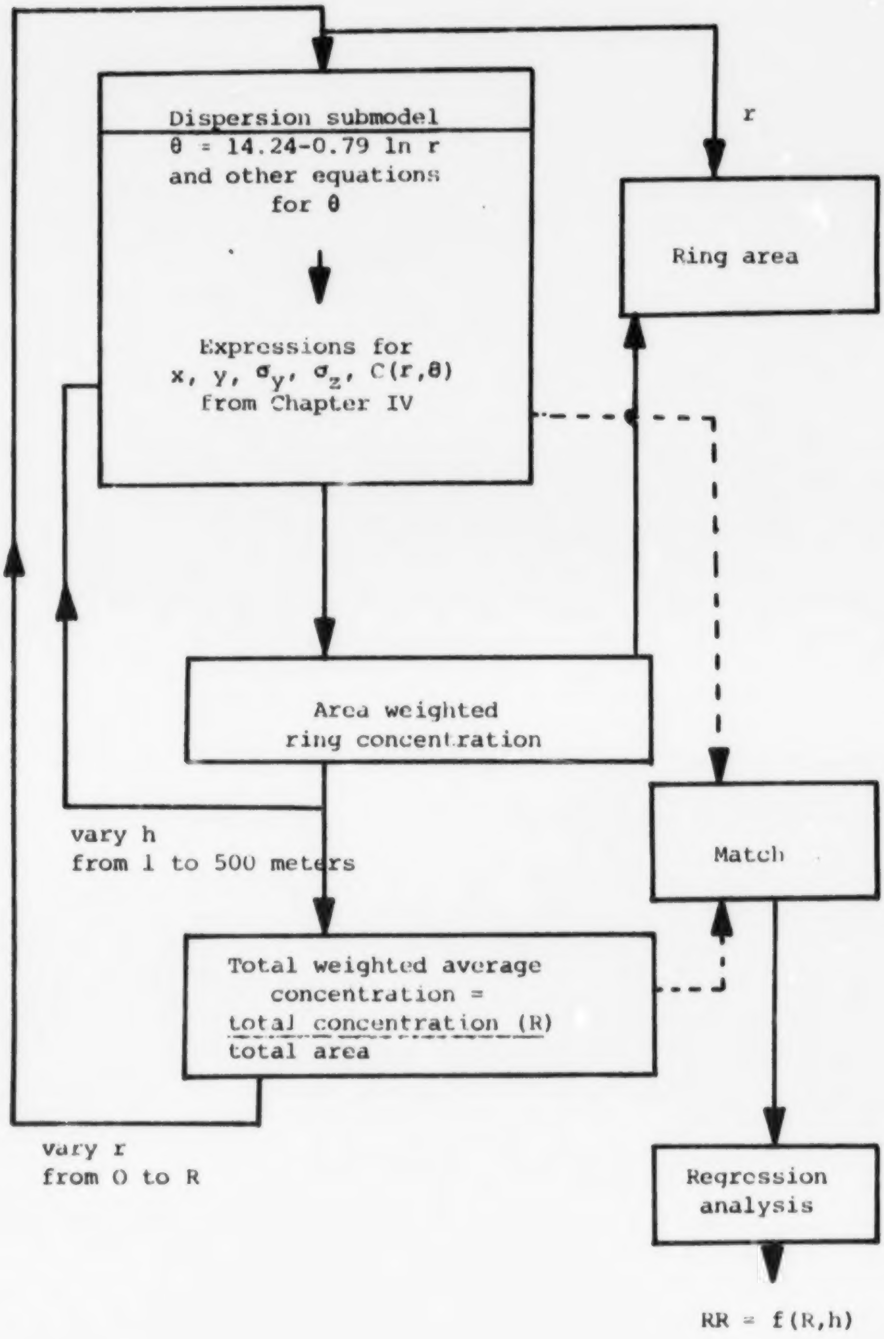

Dispersion submodel
θ = 14.24-0.79 ln r
and other equations
for θ
Expressions for
x, y, σy, σz, C(r,θ)
from Chapter IV
r
Ring area
Area weighted
ring concentration
vary h
from 1 to 500 meters
Match
Total weighted average
concentration =
total concentration (R)
total area
vary r
from 0 to R
Regression
analysis
RR = f(R,h)

Figure 17, Flow diagram: development of population submodel.

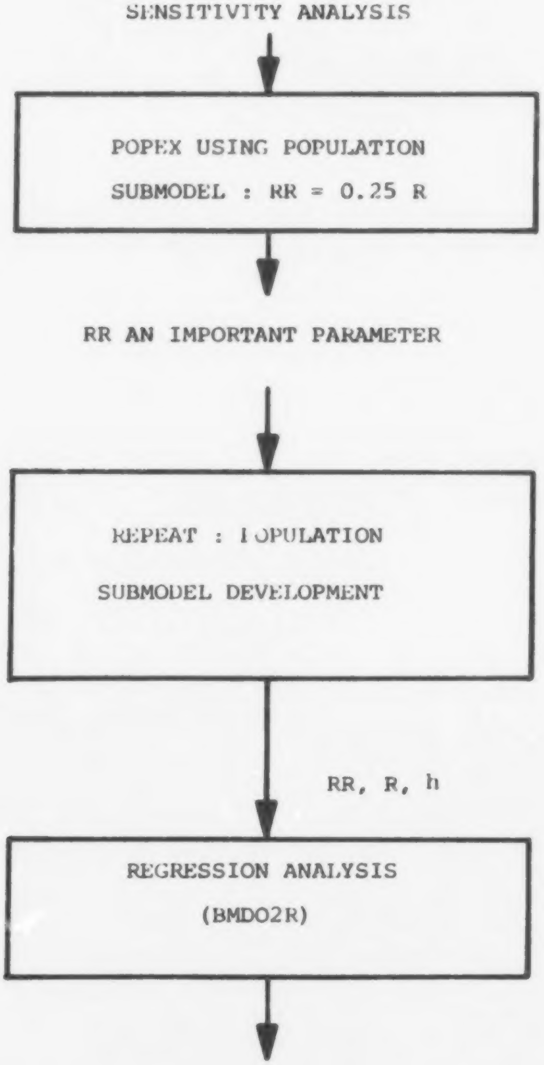
radii were regressed against the height of the stack and county area, and the following equation was obtained (coefficient of determination, $R^2 = .99$):

$$RR = -0.65 + 0.26\ R + 0.02\ h + 0.51\ \ln\ (h) \qquad (7)$$

where RR (kilometers) is the ring radius for height h (meters) and for a specific county size. R is the radius of a circle whose area is equal to the area of the county, or $R = \sqrt{\text{area}/\pi}$.

A word is due about the chronological development of this submodel: equation 7 was actually derived after a second "iteration" of the process described above (Figure 18). Initially, through an analysis similar to Figure 17, but in a less rigorous manner, an approximate equation RR = .25 R was derived and used in the model. Subsequent sensitivity analysis showed that RR greatly influenced the results. Thus, the whole process (Figure 17) was repeated for large numbers of values for R and h and the results were regressed with the help of the Biomedical computer program BMDO2R (34) to arrive at equation 7 (Figure 18).

Finally, the algorithm of this submodel is simple: calculate R for each source from $R = \sqrt{\text{area}/\pi}$, where area is the area of the county in which the source is located. Substitute this R and the stack height, h, into equation 7 to compute RR, or the ring radius, for each source. RR is then used as an input to the dispersion submodel.


SENSITIVITY ANALYSIS
POPEX USING POPULATION
SUBMODEL : RR = 0.25 R
RR AN IMPORTANT PARAMETER
REPEAT : POPULATION
SUBMODEL DEVELOPMENT
RR, R, h
REGRESSION ANALYSIS
(BMDO2R)

$$RR = -0.65 + 0.26r + 0.02h + 0.51 \ln h$$

Figure 18. Sensitivity analysis and improvement of population submodel.

CHAPTER VI

HEALTH-EFFECTS SUBMODEL

INTRODUCTION

The effects of air pollution on human health can be divided into four groups (2): (a) acute sickness or death, (b) insidious or chronic disease, shortening of life, or impairment of growth, (c) alterations of important physiological functions, such as ventilation of the lungs, and (d) discomfort, odor, or eye irritation. Large amounts of work related to these groups of health effects have been done over the past years.

A generalized model for predicting health risks would be extremely valuable for determining the relative impact of different sources of air pollution. There are many "gaps" in the knowledge related to the precise effect of varying dosages of different air pollutants and no data on dose-response relationships relating air pollution dosages to effects on mortality and morbidity were available at the beginning of this project in September 1973. Since early 1974, there has been an extensive effort by the EPA and others (22, 35-37) to construct dose-response curves in terms of aggravation of disease or increase in incidence of a disease. Another approach would be to relate dosages of air pollution to their effects on physiological functions as characterized by a set of clinical indicators. Such an effort is described in Appendix A. However, none of these approaches was general enough to be used for all pollutants. In this project, the need was for an evaluation of the relative effect of different pollutants. The following approach was used for estimation of the relative effects.

DEVELOPMENT

Rationale

A common basis for assessing the relative potential for the deleterious effect of different pollutants was needed. Pindex, initially developed by Babcock (38), provides such a basis. Pindex considers the relative effect of each pollutant and combines individual pollutant levels for a given emission source into a single meaningful number. The tolerance-factor submodel is based on pindex, and the methodology for pindex (39) as well as its data base (40) have undergone substantial revisions. New concepts such as apparent tolerance factors (41) have been added through this research project.

The federal ambient air quality standards (42) are based upon the available knowledge of the deleterious effects of the individual pollutants and seem to be the best available means for relating one pollutant to another as well as for indirect assessment of effects. The basic premise has been that equivalent toxicity, harm, or unpleasantness is experienced when any of the pollutant concentrations reaches its ambient standard. Thus, ambient standards can serve as ready-made tolerance factors for use in this submodel. This submodel is called a tolerance-factor submodel.

Most-stringent standards. - There was, however, the problem of multiple standards for the same pollutant. For example, five different standards were established for sulfur dioxide (Table VI). The work of Larsen (43,44) provided some insight into the problem of multiple standards. He found interesting relationships between annual average concentrations for pollutants and the maximum concentrations present for shorter time periods.

The Larsen relationship is described by Figure 19. The point A indicates the annual average concentration for sulfur dioxide at a certain location. Since this is the annual average, one-half of the readings during the year would be expected to be above, and the other half would be below this average value of A. Thus, approximately half of the readings for any averaging time would lie above the 50 percent probability line with the remainder below this line. It should be noted that this probability line might not be horizontal unless the mean and median values coincide.

To relate maximum concentrations for shorter time averages to the annual average: Larsen found that for a given annual average in a given locality, it would be unlikely that the monthly average would exceed a certain level more than once a year (point B in Figure 19). This point B, as we would expect, is above the annual average, since the annual average lies intermediate between the higher and lower monthly average concentrations. Similarly, the expected maximum

TABLE VI. AIR QUALITY STANDARDS AND TOLERANCE FACTORS (in $\mu g/m^3$)

	EPA STANDARDS					TOLERANCE FACTORS			
Pollutant	Annual measure	Levels not to be exceeded more than once/year				24-hour		Annual	
		24 hr.	8 hr.	3 hr.	1 hr.	Ambient	Emission (apparent)	Ambient	Emission (apparent)
Oxidant					160 (0.08)	59	--	8	--
Sulfur dioxide	80 (0.03)[1]	365 (0.14)				260	260	41	41
(Secondary)	60 (0.02)	260 (0.10)		1300 (0.5)					
Nitrogen oxides[2]	200 (0.1)					800	330	200	53
Carbon monoxide			10,000 (9)		40,000 (35)	7800	7800	2900	2900
Particulate matter	75	260				150	150	54	54
(Secondary)	60	150							
Hydrocarbons				160[3] (0.24)		--	800[4]	--	100[4]

TABLE VI. CONTINUED

Footnotes for Table VI.

[1] The numbers in parentheses are in ppm.

[2] EPA standards are for nitrogen dioxide. It is assumed here that the half of all nitrogen oxides (emission or ambient) in the atmosphere are nitrogen dioxide.

[3] This standard is only applicable to morning rush hours and was not used to determine the hydrocarbon tolerance factors.

[4] These numbers are based on a 1968 emission inventory (46).

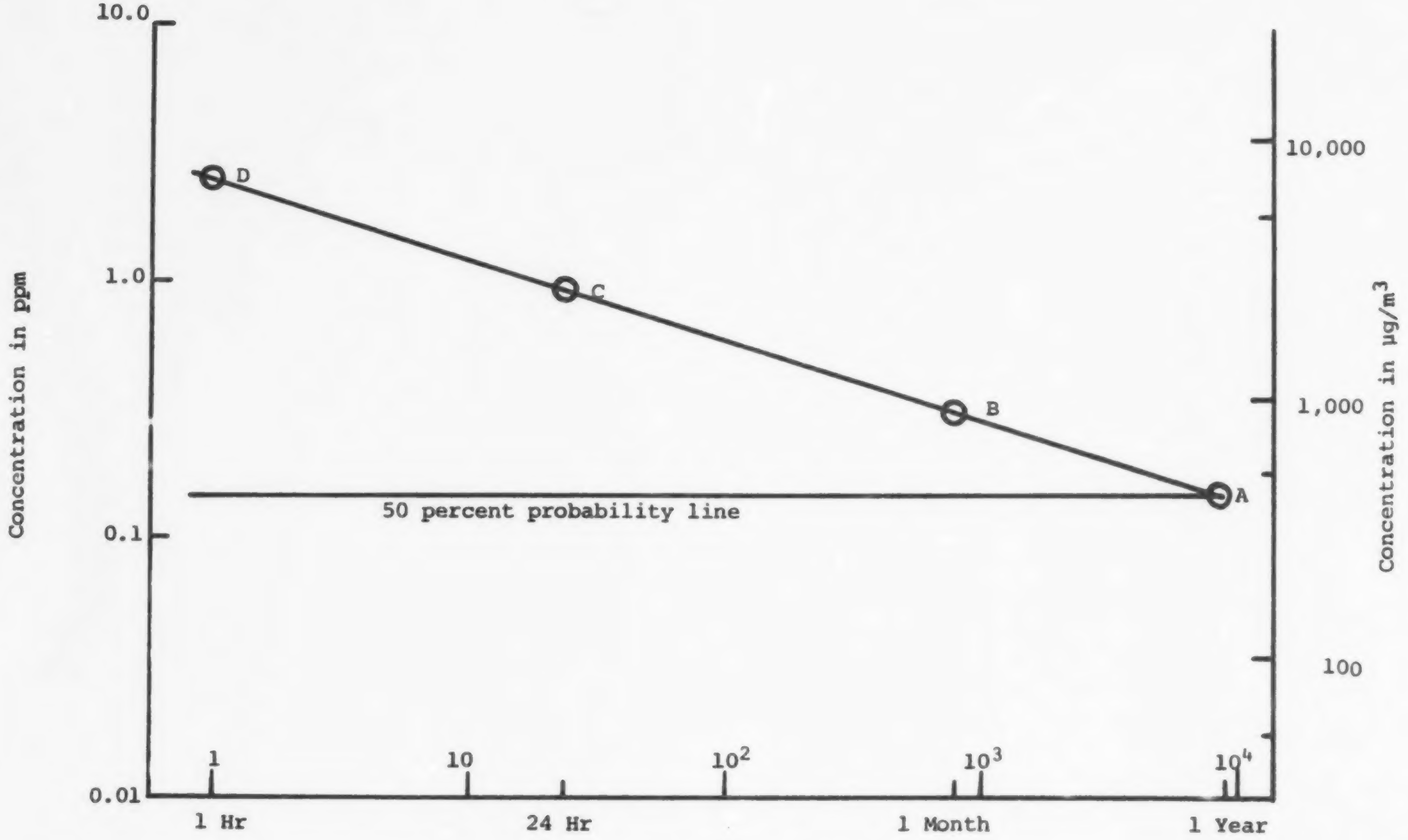


Figure 19. Concentration vs. averaging time for sulfur dioxide.

levels for the 24-hour and 1-hour periods are shown in Figure 19 as points C and D.

Again, it is not surprising that such maximum concentrations rise as the time intervals are reduced. High concentrations for short time intervals are expected and experienced. They are averaged together with below-average values in order to arrive at the intermediate annual average. A line through points A, B, C and D describes the expected maximum concentrations for different sampling times which are associated with a given annual average. If this "line of limits" is exceeded for more than once a year for any time period, the annual average would probably be increased.

Now it is possible to relate this line of limits to the standards for sulfur dioxide. Figure 20 shows the three secondary and two primary standards for sulfur dioxide. The relationship between the standards is not the same as the average Larsen line of limits. The three secondary standards do not lie in a straight line. The reason could be that certain deleterious effects may be detected at a certain concentration over a short period, and other effects may be likely for a different concentration over a longer time interval.

Even though the five standards are not in one line, individual parallel Larsen relationships can be drawn through each of the points as shown on Figure 20. One of them, the lowest line, is clearly the most stringent. If this line is not exceeded, none of the upper lines will be exceeded. This most-stringent relationship is based upon the 24-hour secondary standard. From this line the most-stringent annual

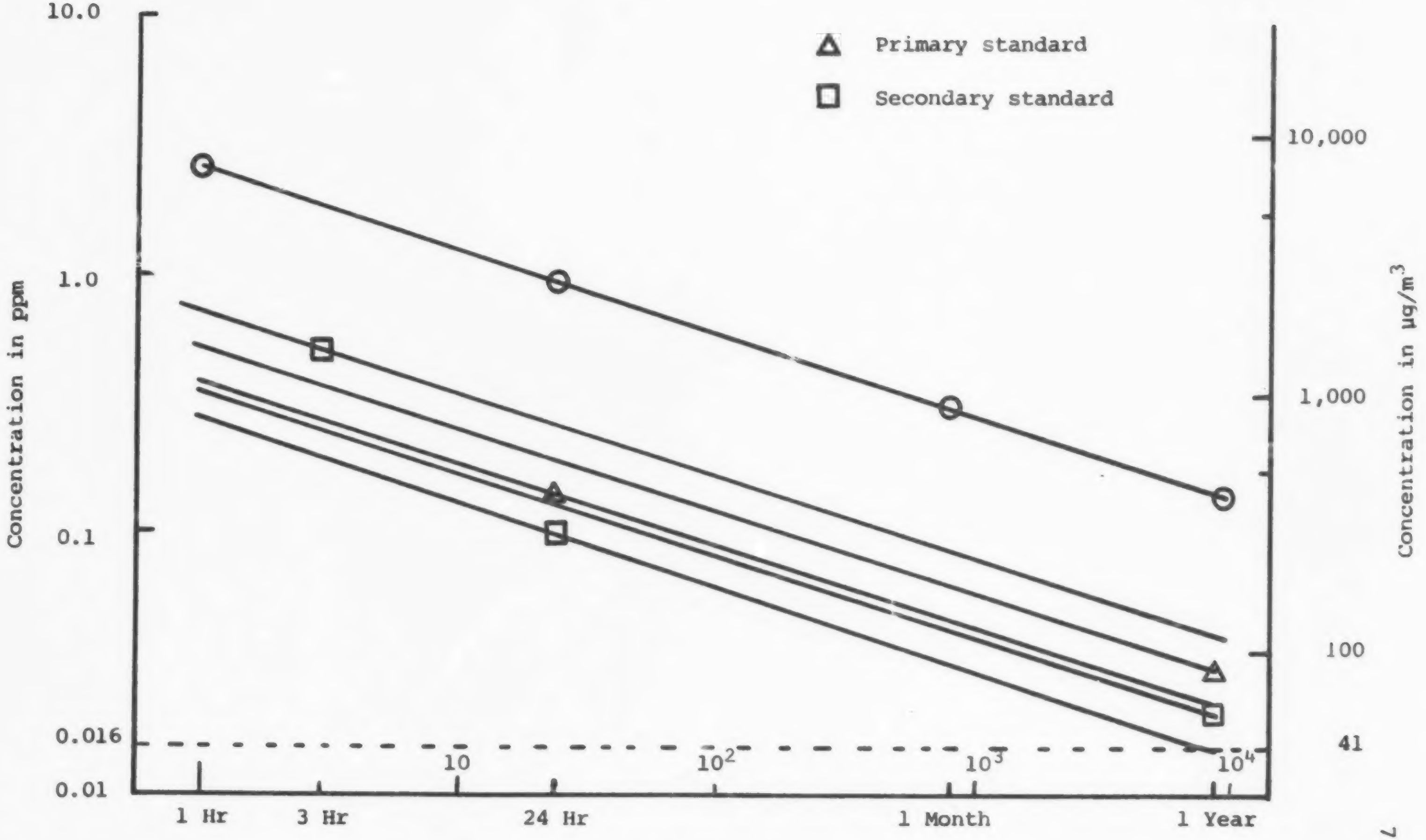


Figure 20. Standards and tolerance factors for sulfur dioxide.

standard or annual-tolerance factor was derived as 0.016 ppm or 41 $\mu g/m^3$ (Table VI) for sulfur dioxide. Similarly, most-stringent annual standards were derived for the other pollutants and are likewise listed on the right-hand side of Table VI. The pertinent background information is listed on Table VII.

The toxicity-factor submodel is based upon these annual tolerance factors thus derived. Apparent tolerance or toxicity factors were computed for nitrogen oxides and hydrocarbons, the pollutants which react to form oxidants. The discussion of photochemistry, as well as the definition and discussion of apparent tolerance factors, is given below.

Photochemical considerations and apparent tolerance factors. - It was assumed that nitrogen oxides and hydrocarbons contribute to photochemical oxidant formation on a one to one molar basis (45). The concept of a limiting reactant is important; if the total number of moles of nitrogen oxides is less than the number of moles of hydrocarbons, the limiting reactant would be nitrogen oxides, and thus theoretically, the maximum amount of oxidant produced would be equal to the number of moles of nitrogen oxides. However, the extent of conversion to oxidant is also affected by solar radiation. In pindex, the reaction to oxidant is assumed to be 22 percent complete (38), based upon the average solar radiation level present in major USA cities.

For example, consider an air pollution source with nitrogen oxide emissions of 20 tons and hydrocarbon emissions of 15 tons; the moles of

TABLE VII. DERIVATION OF TOLERANCE FACTORS

	Slope of Larsen "Line of limits" $\frac{\log(\mu g/m^3)}{\log(hr)}$	Most Stringent Standard $\mu g/m^3$	Extrapolated Annual Ambient Standard $\mu g/m^3$
Oxidant	- 0.335	160 (1 hr)	8
Sulfur dioxide	- 0.315	266 (24 hr secondary)	41
Nitrogen oxides	- 0.246[1]	200 (annual)[2]	200[2]
Carbon moxoxide	- 0.179	10,000 (8 hr)	2900
Particulate matter	- 0.212	150 (24 hr secondary)	54
Hydrocarbons[3]	- 0.238	160 (3 hr)[4]	--

[1] The slope, - 0.246, is for NO_2 and this slope was used in the extrapolation. The corresponding slopes for NO and NO_x are - 0.387 and - 0.310, respectively.

[2] EPA standards are for nitrogen dioxide alone. It is assumed here that the half of all nitrogen oxides in the atmosphere are nitrogen dioxide.

[3] Hydrocarbons assumed to be an oxidant precursor rather than a pollutant.

[4] This standard is only applicable to morning rush hours and was not used to determine the hydrocarbon tolerance factors.

nitrogen oxides emitted are equal to:

$$\frac{\text{weight of } NO_x \text{ in tons}}{\text{molecular weight of } NO_x} = \frac{20}{46} = 0.43 \text{ ton-mole.}$$

Similarly, assuming the average molecular weight of hydrocarbons to be 16, the moles of hydrocarbon emitted are equal to 15/16 or 0.94 ton-mole. Thus, nitrogen oxides is the limiting reactant, and the amount of oxidant formed will be equal to the limiting reactant times the fraction of reaction going to completion:

$$\begin{aligned} \text{oxidant} &= 0.43 \times 0.22 \\ &= 0.095 \text{ ton-moles of oxidant, or} \\ &= 0.095 \times \text{molecular weight of oxidant} \\ &= 4.6 \text{ tons of oxidant} \end{aligned}$$

assuming average molecular weight of oxidant to be 48.

The recent improvements in pindex methodology were related to the method of assigning oxidant contribution (13). In the original model (38), oxidant was formed only to the extent that an individual emission category emitted both nitrogen oxides and hydrocarbons. For example, in the case of a source which has only hydrocarbon emissions and no nitrogen oxides there was no oxidant formation, and no "penalty" was assessed in the original pindex. The tolerance-factor submodel assumes mixing among emissions from different categories such that oxidant can be synthesized from nitrogen oxides from one source and hydrocarbons from another source. The oxidant contribution thus obtained is then prorated back to its precursors, 50 percent to nitrogen oxides and 50 percent to hydrocarbons, regardless of the source.

"Apparent" or emission tolerance factors are also listed in Table VI. These adjusted factors approximate the contributions of nitrogen oxides and hydrocarbons to photochemical oxidant formation such that the oxidant effects can be distributed among nitrogen oxides and hydrocarbon precursor emissions. Hydrocarbons have no tolerance factor listed in the ambient column (Table VI) because they are considered to be solely pollutant precursors rather than actual pollutants. Likewise, no tolerance factor is shown for oxidant emissions because oxidant is usually formed in the atmosphere rather than emitted directly.

The apparent tolerance factors were derived in the following manner: From a nationwide emissions inventory (46), total hydrocarbon emissions are $32.0\text{x}10^6$ tons and total nitrogen oxide emissions are $20.6\text{x}10^6$ tons. Assume average molecular weight is 16 for hydrocarbons and 46 for nitrogen oxides:

$$\text{hydrocarbon emissions} = \frac{32.0}{16} \times 10^6 = 2.0\text{x}10^6 \text{ ton-moles}$$

$$\text{nitrogen oxide emissions} = \frac{20.6}{46} \times 10^6 = 0.45\text{x}10^6 \text{ ton-moles.}$$

Again, nitrogen oxides is the limiting reactant, and from the earlier discussion:

$$\begin{aligned}\text{oxidant} &= 0.45\text{x}10^6\text{x}0.22\\ &= 0.1\ \text{x}10^6 \text{ ton-moles}\\ &= 4.8\ \text{x}10^6 \text{ tons}\end{aligned}$$

This oxidant is in turn prorated equally to both hydrocarbons and nitrogen oxides.

Now, to calculate the apparent tolerance factor for nitrogen oxides:

unreacted nitrogen oxides = $(0.45 - 0.1)10^6$ ton-moles

= $0.35\text{x}10^6$ ton-moles

= $16.1\text{x}10^6$ tons.

The apparent tolerance factor for nitrogen oxides can be determined from the equation:

$$\frac{\text{total } NO_x}{\text{apparent tolerance factor for } NO_x} = \frac{\text{unreacted } NO_x}{\text{tolerance factor for } NO_x} + \frac{\text{oxidant attributed to } NO_x}{\text{oxidant tolerance factor}} \quad (8)$$

Substituting the appropriate tolerance factors from Table VI:

$$\frac{20.6\text{x}10^6}{\text{apparent tolerance factor for } NO_x} = \frac{16.1\text{x}10^6}{200} + \frac{2.4\text{x}10^6}{8}$$

or apparent tolerance factor for NO_x = 53 (when calculated with values for nitrogen oxides and oxidant tolerance factors prior to rounding off).

Similarly for hydrocarbons:

$$\frac{\text{total HC}}{\text{apparent tolerance factor for HC}} = \frac{\text{oxidant attributed to HC}}{\text{oxidant tolerance factor}} \quad (9)$$

$$\frac{32.0\text{x}10^6}{\text{apparent tolerance factor for HC}} = \frac{2.4\text{x}10^6}{8}$$

or apparent tolerance factor for HC = 100 (when calculated with values for oxidant tolerance factor prior to rounding off).

Note that the apparent tolerance factor for nitrogen oxides is independent of the nitrogen-oxides/hydrocarbon emission ratio as long as nitrogen oxides are limiting (almost always the case). Such is no the case for hydrocarbons, since the oxidant "penalty" must be prorated among variable amounts of excess hydrocarbons.

The tolerance factor of 100 for hydrocarbons is based on the 1968 nationwide emission inventory (46) and it could be considered as the upper limit, since hydrocarbon emissions have been steadily decreasing since 1968. On the other extreme, is a case when both nitrogen oxides and hydrocarbon are present in equal-molar basis; for such a case the hydrocarbon tolerance factor will be 25. Similar calculations reveal that the range for 24-hour apparent tolerance factors for hydrocarbons is 175-800. Note that as hydrocarbon emissions are reduced, the remaining hydrocarbon emissions become more significant with regard to oxidant synthesis. A much more realistic appraisal would result if "reactive" rather than "total" hydrocarbons are considered as oxidant precursors. This refinement would require more-explicit emission information than is currently available for most hydrocarbon sources.

Finally, the annual emission (or apparent) tolerance factors given in the extreme right column of Table VI are used in the tolerance-factor submodel. From these annual apparent tolerance factors it is clear that carbon monoxide is the least toxic pollutant. In the model the emissions of all the pollutants are brought to CO-equivalent base for comparison. This is accomplished by multiplying the emissions by a factor TF(pollutant). This factor is given by:

$$TF(K) = \frac{FF(CO)}{FF(K)} \qquad (10)$$

where K is the particular pollutant,

FF(CO) is the tolerance factor for CO, and

FF(K) is the tolerance factor for the pollutant K.

The details of a computer algorithm which uses the mathematical relations developed in this chapter as well as in chapters IV and V are given in the following chapter.

CHAPTER VII

COMPUTER MODELS AND INPUT DATA

COMPUTER MODEL: POPEX

With the simplifications and assumptions utilized in the preceding chapters to arrive at the three submodels, the basic computer algorithm for popex is quite simple and is described below. Details of the computer program are given later.

Computer Algorithm

The definitions of variables used in the following algorithm and their equivalents used in Chapters IV, V and VI are given in Table VIII. The computer algorithm, stepwise, is:

(1) Based on the method given in Chapter VI, combine emissions of the five pollutants for each source into one number:

$$\mathrm{SOURCE(I,N,7)} = \sum_{K=1}^{5} \mathrm{SOURCE(I,N,K)} \times \mathrm{TF(K)}$$

(2) Calculate distances for inter-county and intra-county exposures. For inter-county, distances between the centers of the emitter and the receptor counties are calculated:

$$\mathrm{DIST(I,J)} = \left[(\mathrm{X(I)} - \mathrm{X(J)})^2 + (\mathrm{Y(I)} - \mathrm{Y(J)})^2\right]^{\frac{1}{2}}$$

or $\mathrm{D} = 1.6 \times \mathrm{DIST(I,J)}$ kilometers.

In the case of intra-county exposures, from Chapter V,

$$\mathrm{R} = (\mathrm{AREA(I)}/\pi)^{\frac{1}{2}}$$

TABLE VIII. EXPLANATIONS OF VARIABLES USED IN THE COMPUTER PROGRAM

Terms used in the computer program	Equivalent terms if used in Chapters IV,V,VI	Explanation
ACON(I,J,N)[1]	C	Concentration of air pollutants in County J due to emissions of source N located in County I
AREA(I)		Area of County I
BCON(I,J)		Concentrations in County J due to emissions of all sources in County I
CCON(J)		Concentrations in County J due to emissions of all sources in all the counties
DIST(I,J) or D	r	Distances between the centers of Counties I and J
DIST(I,I) or D	RR, r	Ring of average concentration for County I based on Chapter V
EXP(J)		Total population-pollution effect for County J
FF(K)	FF(K)	Tolerance factor for pollutant K
H or SOURCE(I,N,6)[1]	h	Height of the stack of source N in County I
I		Emitter county
J		Receptor county

TABLE VIII. CONTINUED

Terms used in the computer program	Equivalent terms if used in Chapters IV,V,VI	Explanation
K		Pollutants 1-PM, 2-SO_2, 3-NO_x, 4-CO, 5-HC
N		Source number
NA		Source-category number
POPEXP(NA)		Population-pollution effect due to the source-category NA as percent of the total
R		Radius of a circle whose area is the same as that of a county
SIGMAY	σ_y	Standard deviations of the plume concentration distribution in the crosswind direction
SIGMAZ	σ_z	Standard deviations of plume concentration distribution in the vertical direction
SOURCE(I,N,K)[1] K = 1-5		Emissions of five pollutants
SOURCE(I,N,7)[1]		Combined emissions of the five pollutants based on Chapter VI
SUMEXP		Total population-pollution effect

TABLE VIII. CONTINUED

Terms used in the computer program	Equivalent terms if used in Chapters IV,V,VI	Explanation
TF(K)	TF(K)	A factor based on tolerance factor of pollutants as defined in Chapter VI
THETA	θ	Angle for computing average concentration in the dispersion submodel
X(I)		X-coordinate of center of County I
XX	x	Downwind distance from a source
Y(I)		Y-coordinate of center of County I
YY	y	Crosswind distance from a source
WIND	U	Windspeed

---

[1] To save on storage space, these variables are actually single-string arrays in the computer program. Some of these are converted into three dimensional arrays by the FUNCTIONS ISOD and NAMD described in this chapter.

$$D = \text{DIST}(I,I) = -0.65 + 0.26R + 0.02H + 0.51 \ln(H).$$

(3) From Chapter VI, select an appropriate equation for θ (Table V). For example, for $h < 100$ meters and $1 < D < 4$ km,

$$\theta = 14.56 - 0.79 \ln(D) - 0.08 D$$

$$XX = D \times \text{Cos}(\theta)$$

$$YY = D \times \text{Sin}(\theta)$$

$$\text{SIGMAY} = 0.10167\ XX^{0.917}$$

$$\text{SIGMAZ} = 0.0629\ XX^{0.9}$$

(4) Calculate the concentration:

$$\text{ACON}(I,J,N) = \text{SOURCE}(I,N,7) \times \exp\left(-0.5(YY/\text{SIGMAY})^2\right) \times \exp\left(-0.5(H \times .001/\text{SIGMAZ})^2\right) / (\text{WIND} \times \text{SIGMAY} \times \text{SIGMAZ})$$

(5) Sum the concentrations and the population-weighted concentrations:

$$\text{BCON}(I,J) = \sum_{N \text{ sources}} \text{ACON}(I,J,N)$$

$$\text{CCON}(J) = \sum_{\substack{I,\text{ emitter}\\ \text{counties}}} \text{BCON}(I,J)$$

$$\text{EXP}(J) = \text{CCON}(J) \times \text{POP}(J)$$

$$\text{SUMEXP} = \sum_{J} \text{EXP}(J)$$

(6) Distribute the population-pollution effect back to the individual sources:

$$\text{EXPC}(NA) = \sum_{J} \sum_{I} \sum_{N} \text{ACON}(I,J,N) \times \text{POP}(J)$$

$$\text{POPEXP}(NA) = \text{EXPC}(NA) \times 100/\text{SUMEXP}$$

POPEXP is the percentage contribution of the source-category which is used for popex ranking.

Computer Program

In order to facilitate future updating of the popex model, the computer program was constructed in a modular form. Several subroutines and functions, each for a specific task or set of tasks, were prepared. The flow of the program is given in Figure 21, and a listing of the program is given in Appendix B. The subroutines and functions are briefly described below.

MAIN - This is the central part of the program and is used primarily for control of the program.

CORIBO - Contains the dispersion algorithm and is used for calculating concentrations of emissions at the receptor points.

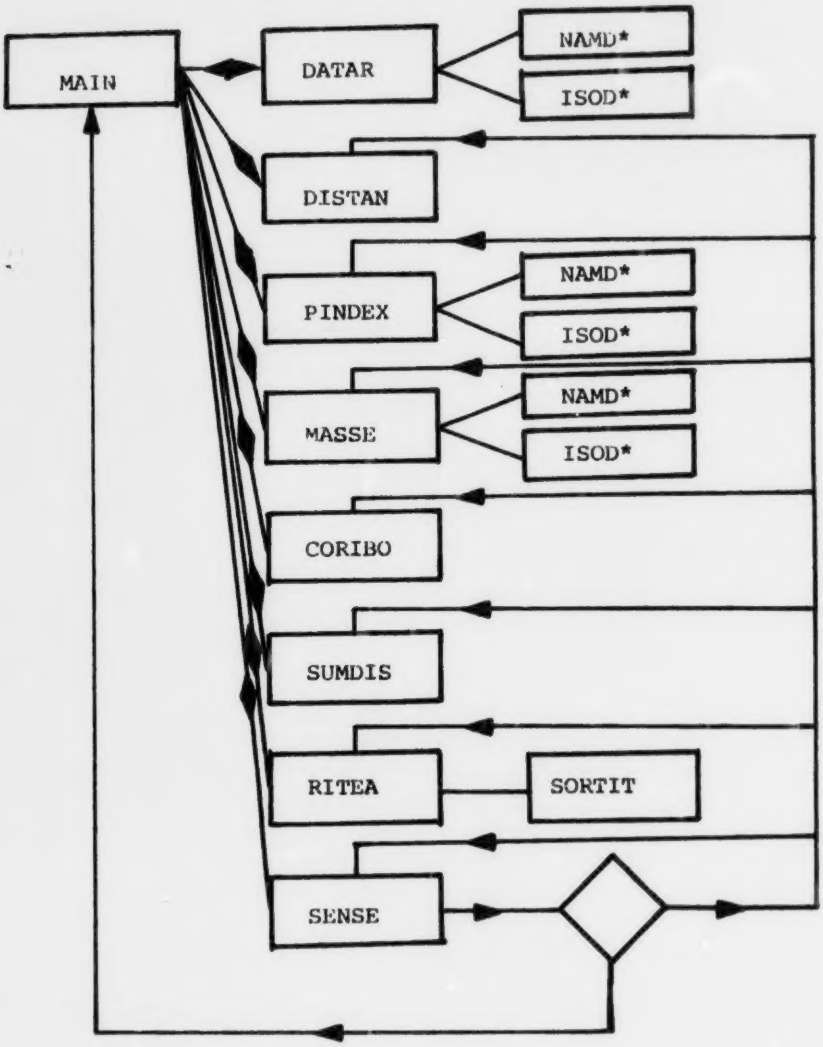
DATAR - All of the data is read by this subroutine. It also prepares tables related to the input data.

DISTAN - Calculates inter-county and intra-county exposure distances based on the population submodel.

ISOD - The function ISOD provides the accessing ease of a three-dimensional array while keeping the storage compactness of a single-dimensional array.

MASSE - This is used to calculate the emission of each pollutant and source in terms of percent of the total AQCR emissions.

NAMD - This function also provides the accessing ease of a two-dimensional array while keeping the storage compactness of a single dimensional array.


MAIN
DATAR
NAMD*
ISOD*
DISTAN
PINDEX
NAMD*
ISOD*
MASSE
NAMD*
ISOD*
CORIBO
SUMDIS
RITEA
SORTIT
SENSE

*these are functions; all others are subroutines

Figure 21. Flow diagram of the popex computer model.

PINDEX - Tolerance factors developed in the health-effect submodel are applied to emissions in this subroutine.

RITEA - Writes out the various results in different formats.

SENSE - In addition to the MAIN, this subroutine controls the program. Values of input parameters are changed arbitrarily for sensitivity analyses of the entire model (see Chapter IX for details).

SORTIT -This subroutine arranges source-categories in decreasing order of their percent contribution to popex.

SUMDIS - SUMDIS sums concentrations and population-exposures from all sources in all counties and prorates the total population-pollution effect back to the individual source-categories for assigning rank-priorities.

COMPUTER MODELS: MASS INDEX AND PINDEX

Two preliminary computer models called mass index and pindex were also developed to form a basis for comparing the results of popex. Mass index expresses the emissions of five pollutants for each of the sources in terms of percentage of the total AQCR emissions. Pindex is analogous to the tolerance-factor submodel and in it the emissions are divided by the tolerance factors. Then "corrected" emissions are normalized to a grand total of 100.

INPUT DATA

Emissions data were obtained from National Emissions Data System (NEDS) of the U. S. Environmental Protection Agency (EPA). Data for the point sources were supplied by NEDS on a magnetic tape. Area-source data were obtained from the printout of point and area emissions. The emissions data on point sources were for 816 source categories as defined by a source classification code (SCC). Emissions of area sources were divided into 41 categories. SCC is a four-number code, with a unique description for each of the 816 point-source-categories. To save on computer storage space, instead of directly using SCC in the computer program, these categories were assigned numbers 1 through 816. The 41 area source categories were assigned numbers 821 through 861. These source numbers (1 through 861) are used in this dissertation. The Appendix C should be referred to to get the corresponding SCC for point sources from the source-category numbers.

Emissions of the individual sources located in each of the eleven counties are given in Appendix D. Stack heights are listed for each source. In cases where there are no stacks, the estimated plume heights given in the NEDS data were used in place of the stack height in the model. For area sources, "stack heights" were assumed (Appendix D). Table IX shows the total emissions of the five pollutants for each of the eleven counties.

The centers and their x and y coordinates of each of the counties are shown in Figure 22 (47). The center of each county is the center of gravity of the geographical area of the county.

TABLE IX. EMISSIONS DATA FOR COUNTIES IN THE CHICAGO AQCR IN TONS/YEAR

OBTAINED FROM APPENDIX D

County	State	PM	SO_2	NO_x	CO	HC
Cook	Illinois	287,832	373,146	280,900	1,559,676	583,912
DuPage	Illinois	6,284	10,656	25,158	153,749	41,586
Grundy	Illinois	13,525	3,592	3,561	18,751	5,393
Kane	Illinois	10,593	10,999	12,914	77,973	27,002
Kankakee	Illinois	7,709	10,537	7,165	38,964	11,030
Kendall	Illinois	574	682	1,499	12,902	3,023
Lake	Illinois	12,988	46,128	31,620	127,050	74,562
McHenry	Illinois	3,120	3,494	6,269	45,809	11,947
Will	Illinois	64,523	63,743	47,046	135,843	81,860
Lake	Indiana	196,738	536,118	121,693	885,200	106,945
Porter	Indiana	7,160	85,928	26,415	41,461	11,566
Total		613,086	1,145,023	564,238	3,097,378	958,826
Grand total for Chicago AQCR		6,378,351 tons/year				

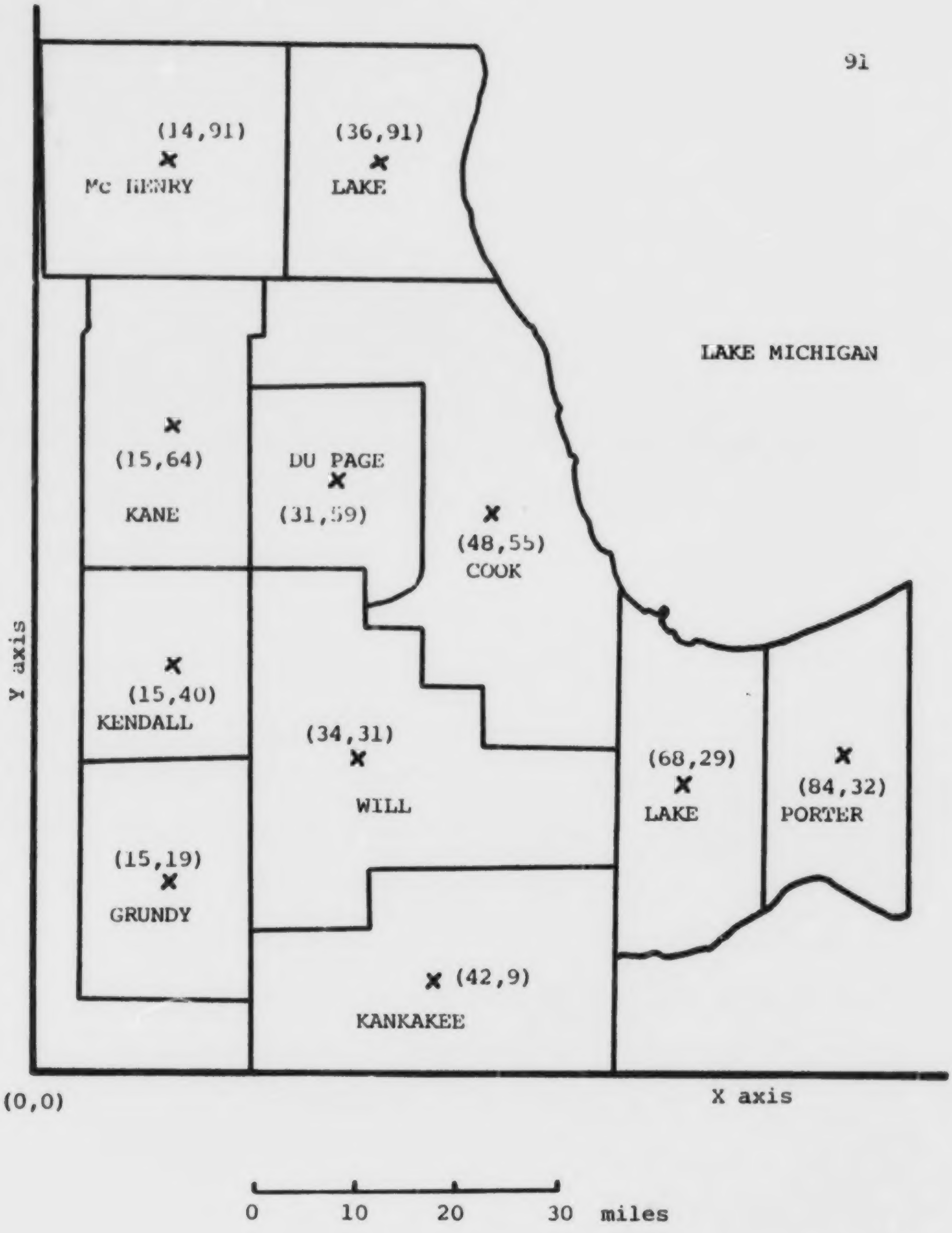

(14,91)
Mc HENRY
(36,91)
LAKE
LAKE MICHIGAN
(15,64)
KANE
DU PAGE
(31,59)
(48,55)
COOK
Y axis
(15,40)
KENDALL
(34,31)
WILL
(68,29)
LAKE
(84,32)
PORTER
(15,19)
GRUNDY
(42,9)
KANKAKEE
(0,0)
X axis
0
10
20
30
miles

Figure 22. Locations of the centers of counties in the Chicago AQCR and their X and Y coordinates.

CHAPTER VIII

RESULTS OF THE POPEX MODEL

FORMAT OF RESULTS

In the Chicago AQCR, there are 227 source-categories out of a total of 857 nationwide source-categories given in Appendix C. As explained earlier, each source-category may include more than one source (Appendix D). Table X lists the results of the popex model along with the emissions, mass index, and pindex for each of the source categories. For each category, the first row lists total emissions, as well as emissions of the five pollutants. The mass index is given on the second line and it gives the emissions of each source-category and of each pollutant in terms of percentage of total emissions for the Chicago AQCR. On the next line pindex for the source-category, as well as prorated pindex for each pollutant in the source-category, are given. Results using the popex model are given on the last line.

To get a better idea of source-priorities, source-categories are listed in the order of decreasing popex in Table XI. The source-category "transportation-gasoline light vehicles" representing automobiles is responsible for 23 percent of popex and is listed first. The three columns on the right (Table XI) list "ranks" for each of the source-categories according to the three models or indices: mass index, pindex, and popex. These ranks are based on percentage contribution to each index (Table XII).

TABLE X. EMISSIONS AND RESULTS OF MASS INDEX, PINDEX AND POPEX FOR EACH OF THE SOURCE-CATEGORIES IN THE CHICAGO AQCR.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
8	EMISSIONS	30752.	1136.	22540.	6780.	226.	70.
	MASS INDEX	0.48	0.02	0.35	0.11	0.00	0.00
	PINDEX	1.16	0.03	0.91	0.21	0.00	0.00
	POPEX	0.46					
9	EMISSIONS	321285.	10027.	275633.	32581.	2339.	705.
	MASS INDEX	5.04	0.16	4.32	0.51	0.04	0.01
	PINDEX	12.51	0.31	11.17	1.02	0.00	0.01
	POPEX	4.45					
10	EMISSIONS	173988.	1323.	135104.	36132.	1099.	330.
	MASS INDEX	2.73	0.02	2.12	0.57	0.02	0.01
	PINDEX	6.65	0.04	5.47	1.13	0.00	0.01
	POPEX	3.59					
11	EMISSIONS	672.	224.	315.	107.	16.	10.
	MASS INDEX	0.01	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.02	0.01	0.01	0.00	0.00	0.00
	POPEX	0.03					
36	EMISSIONS	28438.	538.	15999.	11355.	329.	217.
	MASS INDEX	0.45	0.01	0.25	0.18	0.01	0.00
	PINDEX	1.02	0.02	0.65	0.36	0.00	0.00
	POPEX	0.43					
37	EMISSIONS	99.	2.	70.	25.	1.	1.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.00					
39	EMISSIONS	45.	5.	0.	30.	5.	5.
	MASS INDEX	0.00	0.00	0.0	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.0	0.00	0.00	0.00
	POPEX	0.00					

TABLE X. CONTINUED.

SOURCE CATEGORY		TCTAL	PM	SO2	NOX	CO	HC
42	EMISSIONS	22077.	116.	50.	21169.	678.	64.
	MASS INDEX	0.35	0.00	0.00	0.33	0.01	0.00
	PINDEX	0.67	0.00	0.00	0.66	0.00	0.00
	PCPEX	0.39					
43	EMISSIONS	45.	2.	1.	38.	3.	1.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.00					
45	EMISSIONS	35108.	481.	13490.	20510.	495.	132.
	MASS INDEX	0.55	0.01	0.21	0.32	0.01	0.00
	PINDEX	1.21	0.01	0.55	0.64	0.00	0.00
	POPEX	0.15					
65	EMISSIONS	15258.	2784.	6840.	5400.	180.	54.
	MASS INDEX	0.24	0.04	0.11	0.08	0.00	0.00
	PINDEX	0.33	0.09	0.28	0.17	0.00	0.00
	PCPEX	0.01					
66	EMISSIONS	122579.	32832.	74771.	13967.	776.	233.
	MASS INDEX	1.92	0.51	1.17	0.22	0.01	0.00
	PINDEX	4.48	1.01	3.03	0.44	0.00	0.00
	PCPEX	2.29					
68	EMISSIONS	21736.	3517.	15584.	2196.	293.	146.
	MASS INDEX	0.34	0.05	0.24	0.03	0.00	0.00
	PINDEX	0.81	0.11	0.63	0.07	0.00	0.00
	POPEX	0.43					
70	EMISSIONS	3136.	1006.	1486.	537.	71.	36.
	MASS INDEX	0.05	0.02	0.02	0.01	0.00	0.00
	PINDEX	0.11	0.03	0.06	0.02	0.00	0.00
	PCPEX	0.16					
72	EMISSIONS	20187.	7939.	10140.	1965.	110.	33.
	MASS INDEX	0.32	0.12	0.16	0.03	0.00	0.00
	PINDEX	0.72	0.24	0.41	0.06	0.00	0.00
	PCPEX	0.16					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
73	EMISSIONS	26978.	10128.	13885.	2470.	331.	164.
	MASS INDEX	0.42	0.16	0.22	0.04	0.01	0.00
	PINDEX	0.95	0.31	0.58	0.09	0.00	0.00
	POPEX	0.34					
77	EMISSIONS	76.	19.	38.	6.	10.	3.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.00					
79	EMISSIONS	3450.	429.	1830.	1032.	133.	21.
	MASS INDEX	0.05	0.01	0.03	0.02	0.00	0.00
	PINDEX	0.12	0.01	0.07	0.03	0.00	0.00
	POPEX	0.20					
96	EMISSIONS	60096.	3039.	47926.	8178.	538.	415.
	MASS INDEX	0.94	0.05	0.75	0.13	0.01	0.01
	PINDEX	2.30	0.09	1.94	0.26	0.00	0.01
	POPEX	0.71					
97	EMISSIONS	17415.	999.	13827.	2644.	188.	157.
	MASS INDEX	0.28	0.02	0.22	0.04	0.00	0.00
	PINDEX	0.68	0.03	0.56	0.08	0.00	0.00
	POPEX	0.33					
98	EMISSIONS	1970.	145.	1400.	371.	29.	25.
	MASS INDEX	0.03	0.00	0.02	0.01	0.00	0.00
	PINDEX	0.07	0.00	0.06	0.01	0.00	0.00
	POPEX	0.09					
99	EMISSIONS	1458.	67.	1092.	267.	19.	13.
	MASS INDEX	0.02	0.00	0.02	0.00	0.00	0.00
	PINDEX	0.05	0.00	0.04	0.01	0.00	0.00
	POPEX	0.01					
100	EMISSIONS	62.	3.	45.	12.	1.	1.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.00					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
101	EMISSIONS	225.	15.	138.	59.	7.	6.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.01	0.00	0.01	0.00	0.00	0.00
	PCPEX	0.00					
102	EMISSIONS	2315.	152.	28.	1947.	149.	39.
	MASS INDEX	0.04	0.00	0.00	0.03	0.00	0.00
	PINDEX	0.07	0.00	0.00	0.06	0.00	0.00
	PCPEX	0.03					
103	EMISSIONS	5317.	362.	103.	4396.	341.	115.
	MASS INDEX	0.08	0.01	0.00	0.07	0.01	0.00
	PINDEX	0.16	0.01	0.00	0.14	0.00	0.00
	PCPEX	0.08					
104	EMISSIONS	2199.	247.	34.	1621.	237.	60.
	MASS INDEX	0.03	0.00	0.00	0.03	0.00	0.00
	PINDEX	0.06	0.01	0.00	0.05	0.00	0.00
	PCPEX	0.06					
105	EMISSIONS	64132.	1622.	31110.	29352.	1621.	427.
	MASS INDEX	1.01	0.03	0.49	0.46	0.03	0.01
	PINDEX	2.24	0.05	1.26	0.92	0.00	0.01
	PCPEX	0.78					
106	EMISSIONS	4022.	47.	3257.	676.	15.	27.
	MASS INDEX	0.06	0.00	0.05	0.01	0.00	0.00
	PINDEX	0.15	0.00	0.13	0.02	0.00	0.00
	PCPEX	0.04					
108	EMISSIONS	25540.	280.	22040.	2808.	376.	36.
	MASS INDEX	0.40	0.00	0.35	0.04	0.01	0.00
	PINDEX	0.99	0.01	0.89	0.09	0.00	0.00
	PCPEX	0.59					
110	EMISSIONS	31.	18.	2.	7.	2.	2.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PCPEX	0.00					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
111	EMISSIONS	21.	13.	1.	5.	1.	1.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PCPEX	0.00					
112	EMISSIONS	141.	3.	111.	23.	3.	1.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.01	0.00	0.00	0.00	0.00	0.00
	PCPEX	0.00					
118	EMISSIONS	226.	0.	226.	0.	0.	0.
	MASS INDEX	0.01	0.0	0.01	0.0	0.0	0.0
	PINDEX	0.03	0.0	0.03	0.0	0.0	0.0
	PCPEX	0.01					
128	EMISSIONS	718.	153.	475.	75.	10.	5.
	MASS INDEX	0.01	0.00	0.01	0.00	0.00	0.00
	PINDEX	0.03	0.00	0.02	0.00	0.00	0.00
	PCPEX	0.00					
130	EMISSIONS	15111.	6817.	6584.	1090.	144.	76.
	MASS INDEX	0.24	0.11	0.11	0.02	0.00	0.00
	PINDEX	0.55	0.21	0.28	0.03	0.00	0.00
	PCPEX	0.14					
135	EMISSIONS	36.	1.	17.	1.	14.	3.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PCPEX	0.00					
136	EMISSIONS	672.	278.	332.	52.	8.	2.
	MASS INDEX	0.01	0.00	0.01	0.00	0.00	0.00
	PINDEX	0.02	0.01	0.01	0.00	0.00	0.00
	PCPEX	0.00					
147	EMISSIONS	395.	37.	251.	96.	6.	5.
	MASS INDEX	0.01	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.01	0.00	0.01	0.00	0.00	0.00
	PCPEX	0.04					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
148	EMISSIONS	87.	9.	48.	22.	4.	4.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.01					
149	EMISSIONS	90.	12.	39.	15.	12.	12.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.01					
151	EMISSIONS	268.	25.	132.	94.	9.	8.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.01	0.00	0.01	0.00	0.00	0.00
	POPEX	0.03					
152	EMISSIONS	1362.	99.	849.	369.	34.	11.
	MASS INDEX	0.02	0.00	0.01	0.01	0.00	0.00
	PINDEX	0.05	0.00	0.03	0.01	0.00	0.00
	POPEX	0.01					
153	EMISSIONS	44.	3.	1.	36.	3.	1.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.00					
154	EMISSIONS	133.	13.	6.	89.	16.	9.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.01					
179	EMISSIONS	200.	0.	0.	200.	0.	0.
	MASS INDEX	0.00	0.0	0.0	0.00	0.0	0.0
	PINDEX	0.01	0.0	0.0	0.01	0.0	0.0
	POPEX	0.01					
181	EMISSIONS	749.	0.	0.	0.	0.	749.
	MASS INDEX	0.01	0.0	0.0	0.0	0.0	0.01
	PINDEX	0.01	0.0	0.0	0.0	0.0	0.01
	POPEX	0.02					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
183	EMISSIONS	1618.	0.	0.	0.	1618.	0.
	MASS INDEX	0.03	0.0	0.0	0.0	0.03	0.0
	PINDEX	0.00	0.0	0.0	0.0	0.00	0.0
	PCPEX	0.00					
205	EMISSIONS	1648.	1648.	0.	0.	0.	0.
	MASS INDEX	0.03	0.03	0.0	0.0	0.0	0.0
	PINDEX	0.05	0.05	0.0	0.0	0.0	0.0
	PCPEX	0.10					
208	EMISSIONS	7060.	0.	0.	7060.	0.	0.
	MASS INDEX	0.11	0.0	0.0	0.11	0.0	0.0
	PINDEX	0.22	0.0	0.0	0.22	0.0	0.0
	PCPEX	0.04					
209	EMISSIONS	44.	0.	0.	44.	0.	0.
	MASS INDEX	0.00	0.0	0.0	0.00	0.0	0.0
	PINDEX	0.00	0.0	0.0	0.00	0.0	0.0
	PCPEX	0.00					
210	EMISSIONS	796.	1.	795.	0.	0.	0.
	MASS INDEX	0.01	0.00	0.01	0.0	0.0	0.0
	PINDEX	0.03	0.00	0.03	0.0	0.0	0.0
	PCPEX	0.01					
211	EMISSIONS	2429.	1590.	574.	265.	0.	0.
	MASS INDEX	0.04	0.02	0.01	0.00	0.0	0.0
	PINDEX	0.08	0.05	0.02	0.01	0.0	0.0
	PCPEX	0.01					
221	EMISSIONS	2290.	0.	0.	2290.	0.	0.
	MASS INDEX	0.04	0.0	0.0	0.04	0.0	0.0
	PINDEX	0.07	0.0	0.0	0.07	0.0	0.0
	PCPEX	0.01					
230	EMISSIONS	305.	17.	0.	0.	0.	288.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.00
	PINDEX	0.01	0.00	0.0	0.0	0.0	0.00
	PCPEX	0.01					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
234	EMISSIONS	131.	0.	0.	0.	0.	131.
	MASS INDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.0	0.0	0.0	0.0	0.00
	POPEX	0.00					
237	EMISSIONS	34.	0.	0.	0.	0.	34.
	MASS INDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.0	0.0	0.0	0.0	0.00
	POPEX	0.00					
244	EMISSIONS	414.	414.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.03					
247	EMISSIONS	219.	219.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.01					
249	EMISSIONS	263.	0.	0.	0.	0.	263.
	MASS INDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.0	0.0	0.0	0.0	0.00
	POPEX	0.01					
262	EMISSIONS	851.	72.	779.	0.	0.	0.
	MASS INDEX	0.01	0.00	0.01	0.0	0.0	0.0
	PINDEX	0.03	0.00	0.03	0.0	0.0	0.0
	POPEX	0.01					
263	EMISSIONS	2487.	147.	2340.	0.	0.	0.
	MASS INDEX	0.04	0.00	0.04	0.0	0.0	0.0
	PINDEX	0.10	0.00	0.09	0.0	0.0	0.0
	POPEX	0.02					
267	EMISSIONS	5050.	50.	5000.	0.	0.	0.
	MASS INDEX	0.08	0.00	0.08	0.0	0.0	0.0
	PINDEX	0.20	0.00	0.20	0.0	0.0	0.0
	POPEX	0.05					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
268	EMISSIONS	5900.	0.	5900.	0.	0.	0.
	MASS INDEX	0.09	0.0	0.09	0.0	0.0	0.0
	PINDEX	0.24	0.0	0.24	0.0	0.0	0.0
	POPEX	0.05					
301	EMISSIONS	173.	173.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.01					
305	EMISSIONS	599.	599.	0.	0.	0.	0.
	MASS INDEX	0.02	0.02	0.0	0.0	0.0	0.0
	PINDEX	0.03	0.03	0.0	0.0	0.0	0.0
	POPEX	0.05					
306	EMISSIONS	403.	403.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.02					
333	EMISSIONS	1560.	248.	0.	0.	0.	1312.
	MASS INDEX	0.02	0.00	0.0	0.0	0.0	0.02
	PINDEX	0.03	0.01	0.0	0.0	0.0	0.02
	POPEX	0.04					
345	EMISSIONS	18.	18.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
346	EMISSIONS	65.	65.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
347	EMISSIONS	26.	26.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
349	EMISSIONS	3710.	3710.	0.	0.	0.	0.
	MASS INDEX	0.06	0.06	0.0	0.0	0.0	0.0
	PINDEX	0.11	0.11	0.0	0.0	0.0	0.0
	POPEX	0.23					
350	EMISSIONS	1120.	1120.	0.	0.	0.	0.
	MASS INDEX	0.02	0.02	0.0	0.0	0.0	0.0
	PINDEX	0.03	0.03	0.0	0.0	0.0	0.0
	POPEX	0.07					
351	EMISSIONS	657.	657.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.02	0.02	0.0	0.0	0.0	0.0
	POPEX	0.04					
352	EMISSIONS	408.	408.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.02					
354	EMISSIONS	54.	54.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
361	EMISSIONS	967.	967.	0.	0.	0.	0.
	MASS INDEX	0.02	0.02	0.0	0.0	0.0	0.0
	PINDEX	0.03	0.03	0.0	0.0	0.0	0.0
	POPEX	0.01					
379	EMISSIONS	42.	42.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
389	EMISSIONS	215.	215.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.01					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
399	EMISSIONS	56764.	22060.	0.	254.	8002.	26448.
	MASS INDEX	0.89	0.35	0.0	0.00	0.13	0.41
	PINDEX	1.11	0.68	0.0	0.01	0.00	0.42
	POPEX	0.33					
400	EMISSIONS	25540.	9007.	128.	190.	3143.	13072.
	MASS INDEX	0.40	0.14	0.00	0.00	0.05	0.20
	PINDEX	0.50	0.28	0.01	0.01	0.00	0.21
	POPEX	0.20					
401	EMISSIONS	6250.	4309.	1.	2.	494.	1454.
	MASS INDEX	0.10	0.07	0.00	0.00	0.01	0.02
	PINDEX	0.16	0.13	0.00	0.00	0.00	0.02
	POPEX	0.07					
402	EMISSIONS	5735.	5493.	1.	2.	49.	190.
	MASS INDEX	0.09	0.09	0.00	0.00	0.00	0.00
	PINDEX	0.17	0.17	0.00	0.00	0.00	0.00
	POPEX	0.09					
405	EMISSIONS	17386.	0.	17384.	2.	0.	0.
	MASS INDEX	0.27	0.0	0.27	0.00	0.0	0.0
	PINDEX	0.70	0.0	0.70	0.00	0.0	0.0
	POPEX	0.31					
425	EMISSIONS	1009.	242.	0.	0.	767.	0.
	MASS INDEX	0.02	0.00	0.0	0.0	0.01	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.00	0.0
	POPEX	0.01					
426	EMISSIONS	746.	746.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.02	0.02	0.0	0.0	0.0	0.0
	POPEX	0.01					
427	EMISSIONS	230157.	36057.	0.	0.	194100.	0.
	MASS INDEX	3.61	0.57	0.0	0.0	3.04	0.0
	PINDEX	1.22	1.11	0.0	0.0	0.11	0.0
	POPEX	0.83					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
429	EMISSIONS	2180.	1719.	0.	2.	131.	328.
	MASS INDEX	0.03	0.03	0.0	0.00	0.00	0.01
	PINDEX	0.06	0.05	0.0	0.00	0.00	0.01
	PCPEX	0.03					
433	EMISSIONS	430.	206.	224.	0.	0.	0.
	MASS INDEX	0.01	0.00	0.00	0.0	0.0	0.0
	PINDEX	0.02	0.01	0.01	0.0	0.0	0.0
	PCPEX	0.01					
434	EMISSIONS	22691.	19695.	2996.	0.	0.	0.
	MASS INDEX	0.36	0.31	0.05	0.0	0.0	0.0
	PINDEX	0.73	0.61	0.12	0.0	0.0	0.0
	PCPEX	0.27					
435	EMISSIONS	14506.	3425.	0.	0.	11081.	0.
	MASS INDEX	0.23	0.05	0.0	0.0	0.17	0.0
	PINDEX	0.11	0.11	0.0	0.0	0.01	0.0
	PCPEX	0.06					
436	EMISSIONS	84575.	28211.	0.	0.	56364.	0.
	MASS INDEX	1.33	0.44	0.0	0.0	0.88	0.0
	PINDEX	0.90	0.87	0.0	0.0	0.03	0.0
	PCPEX	0.32					
437	EMISSIONS	113.	113.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PCPEX	0.00					
438	EMISSIONS	157.	151.	26.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.00	0.0	0.0	0.0
	PINDEX	0.01	0.00	0.00	0.0	0.0	0.0
	PCPEX	0.01					
440	EMISSIONS	7.	7.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PCPEX	0.00					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
463	EMISSIONS	524.	524.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.02	0.02	0.0	0.0	0.0	0.0
	POPEX	0.02					
471	EMISSIONS	301.	301.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.02					
472	EMISSIONS	61.	61.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
473	EMISSIONS	6.	6.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
474	EMISSIONS	774.	774.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.02	0.02	0.0	0.0	0.0	0.0
	POPEX	0.04					
475	EMISSIONS	233.	233.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.01					
476	EMISSIONS	90.	90.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.01					
477	EMISSIONS	31451.	961.	15.	0.	30475.	0.
	MASS INDEX	0.49	0.02	0.00	0.0	0.48	0.0
	PINDEX	0.05	0.03	0.00	0.0	0.02	0.0
	POPEX	0.11					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
478	EMISSIONS	7.	7.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
479	EMISSIONS	16.	16.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
485	EMISSIONS	4289.	569.	3720.	0.	0.	0.
	MASS INDEX	0.07	0.01	0.06	0.0	0.0	0.0
	PINDEX	0.17	0.02	0.15	0.0	0.0	0.0
	POPEX	0.32					
494	EMISSIONS	85.	73.	0.	12.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.00	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.00	0.0	0.0
	POPEX	0.00					
495	EMISSIONS	2895.	2876.	0.	19.	0.	0.
	MASS INDEX	0.05	0.05	0.0	0.00	0.0	0.0
	PINDEX	0.09	0.09	0.0	0.00	0.0	0.0
	POPEX	0.07					
498	EMISSIONS	6.	6.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
499	EMISSIONS	162.	2.	0.	0.	0.	160.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.00
	POPEX	0.01					
500	EMISSIONS	41.	41.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					

TABLE X.   CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
502	EMISSIONS	3.	3.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PCPEX	0.00					
504	EMISSIONS	11.	11.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PCPEX	0.00					
520	EMISSIONS	210.	210.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PCPEX	0.01					
522	EMISSIONS	967.	397.	0.	0.	300.	270.
	MASS INDEX	0.02	0.01	0.0	0.0	0.00	0.00
	PINDEX	0.02	0.01	0.0	0.0	0.00	0.00
	PCPEX	0.01					
523	EMISSIONS	155.	155.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PCPEX	0.00					
524	EMISSIONS	9.	9.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PCPEX	0.00					
525	EMISSIONS	39.	19.	0.	0.	20.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.00	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.00	0.0
	PCPEX	0.00					
527	EMISSIONS	1011.	1003.	5.	3.	0.	0.
	MASS INDEX	0.02	0.02	0.00	0.00	0.0	0.0
	PINDEX	0.03	0.03	0.00	0.00	0.0	0.0
	PCPEX	0.04					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
528	EMISSIONS	8625.	8625.	0.	0.	0.	0.
	MASS INDEX	0.14	0.14	0.0	0.0	0.0	0.0
	PINDEX	0.27	0.27	0.0	0.0	0.0	0.0
	PCPEX	0.47					
530	EMISSIONS	996.	996.	0.	0.	0.	0.
	MASS INDEX	0.02	0.02	0.0	0.0	0.0	0.0
	PINDEX	0.03	0.03	0.0	0.0	0.0	0.0
	POPEX	0.06					
531	EMISSIONS	1560.	1560.	0.	0.	0.	0.
	MASS INDEX	0.02	0.02	0.0	0.0	0.0	0.0
	PINDEX	0.05	0.05	0.0	0.0	0.0	0.0
	POPEX	0.08					
533	EMISSIONS	28.	2.	2.	18.	4.	2.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PCPEX	0.00					
541	EMISSIONS	129.	129.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PUPEX	0.00					
544	EMISSICNS	2.	2.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PCPEX	0.00					
546	EMISSIONS	49.	49.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PCPEX	0.00					
547	EMISSICNS	1400.	1400.	0.	0.	0.	0.
	MASS INDEX	0.02	0.02	0.0	0.0	0.0	0.0
	PINDEX	0.04	0.04	0.0	0.0	0.0	0.0
	PCPEX	[illegible]					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
548	EMISSIONS	539.	539.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.02	0.02	0.0	0.0	0.0	0.0
	POPEX	0.03					
551	EMISSIONS	9320.	3500.	5820.	0.	0.	0.
	MASS INDEX	0.15	0.05	0.09	0.0	0.0	0.0
	PINDEX	0.34	0.11	0.24	0.0	0.0	0.0
	POPEX	0.10					
559	EMISSIONS	859.	858.	0.	1.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.00	0.0	0.0
	PINDEX	0.03	0.03	0.0	0.00	0.0	0.0
	POPEX	0.00					
560	EMISSIONS	3024.	3023.	0.	1.	0.	0.
	MASS INDEX	0.05	0.05	0.0	0.00	0.0	0.0
	PINDEX	0.09	0.09	0.0	0.00	0.0	0.0
	POPEX	0.01					
579	EMISSIONS	79.	0.	0.	0.	0.	79.
	MASS INDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.0	0.0	0.0	0.0	0.00
	POPEX	0.00					
582	EMISSIONS	252.	252.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.01					
589	EMISSIONS	155.	155.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
590	EMISSIONS	10.	10.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
591	EMISSIONS	20.	20.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
592	EMISSIONS	5932.	5932.	0.	0.	0.	0.
	MASS INDEX	0.09	0.09	0.0	0.0	0.0	0.0
	PINDEX	0.18	0.18	0.0	0.0	0.0	0.0
	POPEX	0.03					
593	EMISSIONS	706.	706.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.02	0.02	0.0	0.0	0.0	0.0
	POPEX	0.00					
595	EMISSIONS	25910.	25910.	0.	0.	0.	0.
	MASS INDEX	0.41	0.41	0.0	0.0	0.0	0.0
	PINDEX	0.80	0.80	0.0	0.0	0.0	0.0
	POPEX	1.23					
605	EMISSIONS	42.	42.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
610	EMISSIONS	1537.	1537.	0.	0.	0.	0.
	MASS INDEX	0.02	0.02	0.0	0.0	0.0	0.0
	PINDEX	0.05	0.05	0.0	0.0	0.0	0.0
	POPEX	0.01					
611	EMISSIONS	3481.	3481.	0.	0.	0.	0.
	MASS INDEX	0.05	0.05	0.0	0.0	0.0	0.0
	PINDEX	0.11	0.11	0.0	0.0	0.0	0.0
	POPEX	0.02					
612	EMISSIONS	18295.	18295.	0.	0.	0.	0.
	MASS INDEX	0.29	0.29	0.0	0.0	0.0	0.0
	PINDEX	0.55	0.55	0.0	0.0	0.0	0.0
	POPEX	0.12					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
614	EMISSIONS	899.	899.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.03	0.03	0.0	0.0	0.0	0.0
	POPEX	0.00					
615	EMISSIONS	4103.	4103.	0.	0.	0.	0.
	MASS INDEX	0.05	0.06	0.0	0.0	0.0	0.0
	PINDEX	0.13	0.13	0.0	0.0	0.0	0.0
	POPEX	0.05					
616	EMISSIONS	17334.	17334.	0.	0.	0.	0.
	MASS INDEX	0.27	0.27	0.0	0.0	0.0	0.0
	PINDEX	0.53	0.53	0.0	0.0	0.0	0.0
	POPEX	0.10					
617	EMISSIONS	46295.	46295.	0.	0.	0.	0.
	MASS INDEX	0.73	0.73	0.0	0.0	0.0	0.0
	PINDEX	1.42	1.42	0.0	0.0	0.0	0.0
	POPEX	2.29					
632	EMISSIONS	3290.	3290.	0.	0.	0.	0.
	MASS INDEX	0.05	0.05	0.0	0.0	0.0	0.0
	PINDEX	0.10	0.10	0.0	0.0	0.0	0.0
	POPEX	0.21					
633	EMISSIONS	25241.	606.	22447.	2087.	0.	101.
	MASS INDEX	0.40	0.01	0.35	0.03	0.0	0.00
	PINDEX	0.99	0.02	0.91	0.07	0.0	0.00
	POPEX	0.26					
634	EMISSIONS	9576.	63.	7668.	1614.	0.	211.
	MASS INDEX	0.15	0.00	0.12	0.03	0.0	0.00
	PINDEX	0.37	0.00	0.31	0.05	0.0	0.00
	POPEX	0.14					
637	EMISSIONS	361839.	3414.	7322.	1616.	344490.	4997.
	MASS INDEX	5.67	0.05	0.11	0.03	5.40	0.08
	PINDEX	0.73	0.10	0.30	0.05	0.20	0.08
	POPEX	0.54					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
638	EMISSIONS	5108.	269.	3740.	88.	988.	23.
	MASS INDEX	0.08	0.00	0.06	0.00	0.02	0.00
	PINDEX	0.16	0.01	0.15	0.00	0.00	0.00
	POPEX	0.04					
639	EMISSIONS	69.	0.	0.	0.	0.	69.
	MASS INDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.0	0.0	0.0	0.0	0.00
	POPEX	0.00					
642	EMISSIONS	3280.	0.	0.	0.	0.	3280.
	MASS INDEX	0.05	0.0	0.0	0.0	0.0	0.05
	PINDEX	0.05	0.0	0.0	0.0	0.0	0.05
	POPEX	0.01					
645	EMISSIONS	3000.	0.	0.	0.	0.	3000.
	MASS INDEX	0.05	0.0	0.0	0.0	0.0	0.05
	PINDEX	0.05	0.0	0.0	0.0	0.0	0.05
	POPEX	0.01					
646	EMISSIONS	389.	0.	0.	0.	0.	389.
	MASS INDEX	0.01	0.0	0.0	0.0	0.0	0.01
	PINDEX	0.01	0.0	0.0	0.0	0.0	0.01
	POPEX	0.00					
647	EMISSIONS	153.	0.	0.	0.	0.	153.
	MASS INDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.0	0.0	0.0	0.0	0.00
	POPEX	0.00					
648	EMISSIONS	236.	0.	0.	0.	0.	236.
	MASS INDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.0	0.0	0.0	0.0	0.00
	POPEX	0.00					
649	EMISSIONS	69.	0.	0.	0.	0.	69.
	MASS INDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.0	0.0	0.0	0.0	0.00
	POPEX	0.00					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
650	EMISSIONS	128.	0.	0.	0.	0.	128.
	MASS INDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.0	0.0	0.0	0.0	0.00
	POPEX	0.00					
651	EMISSIONS	12.	0.	12.	0.	0.	0.
	MASS INDEX	0.00	0.0	0.00	0.0	0.0	0.0
	PINDEX	0.00	0.0	0.00	0.0	0.0	0.0
	POPEX	0.00					
657	EMISSIONS	205561.	0.	36531.	2630.	166000.	0.
	MASS INDEX	3.22	0.0	0.58	0.04	2.60	0.0
	PINDEX	1.67	0.0	1.50	0.08	0.10	0.0
	POPEX	0.43					
658	EMISSIONS	33061.	2630.	27337.	2167.	0.	927.
	MASS INDEX	0.52	0.04	0.43	0.03	0.0	0.01
	PINDEX	1.27	0.08	1.11	0.07	0.0	0.01
	POPEX	0.96					
677	EMISSIONS	8.	8.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.00	0.00	0.0	0.0	0.0	0.0
	POPEX	0.00					
692	EMISSIONS	666.	666.	0.	0.	0.	0.
	MASS INDEX	0.01	0.01	0.0	0.0	0.0	0.0
	PINDEX	0.02	0.02	0.0	0.0	0.0	0.0
	POPEX	0.04					
693	EMISSIONS	197.	197.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.01					
706	EMISSIONS	15.	0.	15.	0.	0.	0.
	MASS INDEX	0.00	0.0	0.00	0.0	0.0	0.0
	PINDEX	0.00	0.0	0.00	0.0	0.0	0.0
	POPEX	0.00					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
714	EMISSIONS	232.	0.	229.	3.	0.	0.
	MASS INDEX	0.00	0.0	0.00	0.00	0.0	0.0
	PINDEX	0.01	0.0	0.01	0.00	0.0	0.0
	POPEX	0.00					
730	EMISSIONS	8.	0.	5.	3.	0.	0.
	MASS INDEX	0.00	0.0	0.00	0.00	0.0	0.0
	PINDEX	0.00	0.0	0.00	0.00	0.0	0.0
	POPEX	0.00					
731	EMISSIONS	242.	242.	0.	0.	0.	0.
	MASS INDEX	0.00	0.00	0.0	0.0	0.0	0.0
	PINDEX	0.01	0.01	0.0	0.0	0.0	0.0
	POPEX	0.01					
737	EMISSIONS	7643.	17.	3925.	204.	0.	3497.
	MASS INDEX	0.12	0.00	0.06	0.00	0.0	0.05
	PINDEX	0.22	0.00	0.16	0.01	0.0	0.06
	POPEX	0.18					
739	EMISSIONS	468.	0.	0.	0.	0.	468.
	MASS INDEX	0.01	0.0	0.0	0.0	0.0	0.01
	PINDEX	0.01	0.0	0.0	0.0	0.0	0.01
	POPEX	0.00					
741	EMISSIONS	679.	0.	0.	0.	0.	679.
	MASS INDEX	0.01	0.0	0.0	0.0	0.0	0.01
	PINDEX	0.01	0.0	0.0	0.0	0.0	0.01
	POPEX	0.00					
743	EMISSIONS	13826.	101.	0.	0.	0.	13725.
	MASS INDEX	0.22	0.00	0.0	0.0	0.0	0.22
	PINDEX	0.22	0.00	0.0	0.0	0.0	0.22
	POPEX	0.33					
744	EMISSIONS	574.	0.	0.	0.	0.	574.
	MASS INDEX	0.01	0.0	0.0	0.0	0.0	0.01
	PINDEX	0.01	0.0	0.0	0.0	0.0	0.01
	POPEX	0.02					

TABLE X, CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
745	EMISSIONS	38307.	0.	0.	0.	0.	38307.
	MASS INDEX	0.60	0.0	0.0	0.0	0.0	0.60
	PINDEX	0.61	0.0	0.0	0.0	0.0	0.61
	PUPEX	1.14					
746	EMISSIONS	4581.	0.	0.	0.	0.	4581.
	MASS INDEX	0.07	0.0	0.0	0.0	0.0	0.07
	PINDEX	0.07	0.0	0.0	0.0	0.0	0.07
	PUPEX	0.13					
747	EMISSIONS	3159.	0.	0.	0.	0.	3159.
	MASS INDEX	0.05	0.0	0.0	0.0	0.0	0.05
	PINDEX	0.05	0.0	0.0	0.0	0.0	0.05
	PUPEX	0.08					
748	EMISSIONS	289.	0.	0.	0.	0.	289.
	MASS INDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PINDEX	0.00	0.0	0.0	0.0	0.0	0.00
	PUPEX	0.00					
749	EMISSIONS	58702.	0.	0.	0.	0.	58702.
	MASS INDEX	0.92	0.0	0.0	0.0	0.0	0.92
	PINDEX	0.94	0.0	0.0	0.0	0.0	0.94
	PUPEX	0.37					
750	EMISSIONS	1935.	0.	0.	0.	0.	1935.
	MASS INDEX	0.03	0.0	0.0	0.0	0.0	0.03
	PINDEX	0.03	0.0	0.0	0.0	0.0	0.03
	PUPEX	0.01					
751	EMISSIONS	42878.	0.	0.	0.	0.	42878.
	MASS INDEX	0.67	0.0	0.0	0.0	0.0	0.67
	PINDEX	0.68	0.0	0.0	0.0	0.0	0.68
	PUPEX	0.26					
752	EMISSIONS	2230.	0.	0.	0.	0.	2230.
	MASS INDEX	0.03	0.0	0.0	0.0	0.0	0.03
	PINDEX	0.04	0.0	0.0	0.0	0.0	0.04
	PUPEX	0.01					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
758	EMISSIONS	876.	0.	0.	0.	0.	876.
	MASS INDEX	0.01	0.0	0.0	0.0	0.0	0.01
	PINDEX	0.01	0.0	0.0	0.0	0.0	0.01
	POPEX	0.03					
760	EMISSIONS	477.	0.	0.	0.	0.	477.
	MASS INDEX	0.01	0.0	0.0	0.0	0.0	0.01
	PINDEX	0.01	0.0	0.0	0.0	0.0	0.01
	POPEX	0.01					
761	EMISSIONS	26304.	9299.	1003.	800.	14000.	602.
	MASS INDEX	0.41	0.16	0.02	0.01	0.22	0.01
	PINDEX	0.39	0.30	0.04	0.03	0.01	0.01
	POPEX	0.52					
762	EMISSIONS	4118.	828.	210.	167.	1664.	1249.
	MASS INDEX	0.06	0.01	0.00	0.00	0.03	0.02
	PINDEX	0.06	0.03	0.01	0.01	0.00	0.02
	POPEX	0.09					
778	EMISSIONS	85.	23.	4.	4.	31.	23.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.00					
782	EMISSIONS	4492.	1046.	0.	123.	3077.	246.
	MASS INDEX	0.07	0.02	0.0	0.00	0.05	0.00
	PINDEX	0.04	0.03	0.0	0.00	0.00	0.00
	POPEX	0.11					
783	EMISSIONS	31.	13.	1.	1.	9.	7.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.00					
795	EMISSIONS	301.	74.	31.	37.	122.	37.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.01	0.00	0.00	0.00	0.00	0.00
	POPEX	0.00					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
796	EMISSIONS	12376.	3339.	572.	459.	4029.	3978.
	MASS INDEX	0.19	0.05	0.01	0.01	0.06	0.06
	PINDEX	0.21	0.10	0.02	0.01	0.00	0.06
	POPEX	0.22					
797	EMISSIONS	17.	2.	2.	13.	0.	0.
	MASS INDEX	0.00	0.00	0.00	0.00	0.0	0.0
	PINDEX	0.00	0.00	0.00	0.00	0.0	0.0
	POPEX	0.00					
802	EMISSIONS	10.	1.	1.	1.	2.	5.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.00					
821	EMISSIONS	134.	11.	23.	3.	95.	2.
	MASS INDEX	0.00	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.00	0.00	0.00	0.00
	POPEX	0.00					
822	EMISSIONS	137514.	11397.	60719.	1709.	51292.	12397.
	MASS INDEX	2.16	0.18	0.95	0.03	0.80	0.19
	PINDEX	3.09	0.35	2.46	0.05	0.03	0.20
	POPEX	5.49					
823	EMISSIONS	49237.	5672.	32219.	6807.	2837.	1702.
	MASS INDEX	0.77	0.09	0.51	0.11	0.04	0.03
	PINDEX	1.72	0.17	1.31	0.21	0.00	0.03
	POPEX	2.73					
825	EMISSIONS	15149.	2950.	92.	7761.	3105.	1241.
	MASS INDEX	0.24	0.05	0.00	0.12	0.05	0.02
	PINDEX	0.36	0.09	0.00	0.24	0.00	0.02
	POPEX	0.56					
826	EMISSIONS	37.	24.	0.	9.	2.	2.
	MASS INDEX	0.00	0.00	0.0	0.00	0.00	0.00
	PINDEX	0.00	0.00	0.0	0.00	0.00	0.00
	POPEX	0.00					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
828	EMISSIONS	229896.	104518.	107518.	14880.	1987.	993.
	MASS INDEX	3.60	1.64	1.69	0.23	0.03	0.02
	PINDEX	8.05	3.21	4.36	0.47	0.00	0.02
	PCPEX	12.48					
829	EMISSIONS	9913.	927.	6438.	2419.	7.	122.
	MASS INDEX	0.16	0.01	0.10	0.04	0.00	0.00
	PINDEX	0.37	0.03	0.26	0.08	0.00	0.00
	PCPEX	0.61					
830	EMISSIONS	7192.	799.	3026.	3196.	9.	160.
	MASS INDEX	0.11	0.01	0.05	0.05	0.00	0.00
	PINDEX	0.25	0.02	0.12	0.10	0.00	0.00
	PCPEX	0.39					
831	EMISSIONS	20914.	1575.	52.	15752.	2568.	967.
	MASS INDEX	0.33	0.02	0.00	0.25	0.04	0.02
	PINDEX	0.56	0.05	0.00	0.49	0.00	0.02
	PCPEX	0.85					
835	EMISSIONS	5162.	1375.	3303.	242.	190.	52.
	MASS INDEX	0.08	0.02	0.05	0.00	0.00	0.00
	PINDEX	0.18	0.04	0.13	0.01	0.00	0.00
	PCPEX	0.07					
836	EMISSIONS	47178.	4454.	30444.	11661.	58.	561.
	MASS INDEX	0.74	0.07	0.48	0.18	0.00	0.01
	PINDEX	1.74	0.14	1.23	0.37	0.00	0.01
	PCPEX	2.81					
837	EMISSIONS	2229.	248.	938.	990.	3.	50.
	MASS INDEX	0.03	0.00	0.01	0.02	0.00	0.00
	PINDEX	0.08	0.01	0.04	0.03	0.00	0.00
	PCPEX	0.03					
838	EMISSIONS	6968.	897.	27.	4723.	945.	376.
	MASS INDEX	0.11	0.01	0.00	0.07	0.01	0.01
	PINDEX	0.18	0.03	0.00	0.15	0.00	0.01
	PCPEX	0.28					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
840	EMISSIONS	85871.	5570.	99.	200.	59703.	19899.
	MASS INDEX	1.35	0.09	0.00	0.00	0.94	0.31
	PINDEX	0.55	0.18	0.00	0.01	0.03	0.32
	POPEX	0.60					
841	EMISSIONS	21714.	2447.	152.	918.	12998.	5199.
	MASS INDEX	0.34	0.04	0.00	0.01	0.20	0.08
	PINDEX	0.20	0.08	0.01	0.03	0.01	0.08
	POPEX	0.30					
842	EMISSIONS	3012.	795.	99.	135.	1323.	660.
	MASS INDEX	0.05	0.01	0.00	0.00	0.02	0.01
	PINDEX	0.04	0.02	0.00	0.00	0.00	0.01
	POPEX	0.05					
843	EMISSIONS	7237.	815.	50.	304.	4334.	1734.
	MASS INDEX	0.11	0.01	0.00	0.00	0.07	0.03
	PINDEX	0.07	0.03	0.00	0.01	0.00	0.03
	POPEX	0.10					
844	EMISSIONS	80356.	21193.	2649.	3532.	35320.	17662.
	MASS INDEX	1.26	0.33	0.04	0.06	0.55	0.28
	PINDEX	1.17	0.65	0.11	0.11	0.02	0.28
	POPEX	1.90					
845	EMISSIONS	125367.	14125.	882.	5297.	75044.	30019.
	MASS INDEX	1.97	0.22	0.01	0.08	1.18	0.47
	PINDEX	1.16	0.43	0.04	0.17	0.04	0.48
	POPEX	1.87					
846	EMISSIONS	2145863.	11042.	6627.	168266.	1648286.	321642.
	MASS INDEX	33.64	0.17	0.10	2.48	25.84	5.04
	PINDEX	11.65	0.34	0.27	4.96	0.94	5.14
	POPEX	22.89					
847	EMISSIONS	295370.	833.	500.	27741.	213086.	53210.
	MASS INDEX	4.63	0.01	0.01	0.43	3.34	0.83
	PINDEX	1.89	0.03	0.02	0.87	0.12	0.85
	POPEX	2.69					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
848	EMISSIONS	71811.	160.	98.	3493.	57079.	10981.
	MASS INDEX	1.13	0.00	0.00	0.05	0.89	0.17
	PINDEX	0.33	0.00	0.00	0.11	0.03	0.18
	POPEX	0.17					
849	EMISSIONS	77336.	1521.	3043.	43107.	25355.	4310.
	MASS INDEX	1.21	0.02	0.05	0.68	0.40	0.07
	PINDEX	1.60	0.05	0.12	1.35	0.01	0.07
	POPEX	2.75					
850	EMISSIONS	9724.	188.	391.	5353.	3255.	537.
	MASS INDEX	0.15	0.00	0.01	0.08	0.05	0.01
	PINDEX	0.20	0.01	0.02	0.17	0.00	0.01
	POPEX	0.26					
851	EMISSIONS	32854.	2882.	7494.	8646.	8069.	5763.
	MASS INDEX	0.52	0.05	0.12	0.14	0.13	0.09
	PINDEX	0.76	0.09	0.30	0.27	0.00	0.09
	POPEX	1.12					
852	EMISSIONS	1337.	206.	40.	98.	514.	479.
	MASS INDEX	0.02	0.00	0.00	0.00	0.01	0.01
	PINDEX	0.02	0.01	0.00	0.00	0.00	0.01
	POPEX	0.03					
853	EMISSIONS	3180.	100.	20.	91.	2527.	442.
	MASS INDEX	0.05	0.00	0.00	0.00	0.04	0.01
	PINDEX	0.02	0.00	0.00	0.00	0.00	0.01
	POPEX	0.02					
854	EMISSIONS	31895.	3209.	711.	2008.	18266.	7701.
	MASS INDEX	0.50	0.05	0.01	0.03	0.29	0.12
	PINDEX	0.32	0.10	0.03	0.06	0.01	0.12
	POPEX	0.65					
856	EMISSIONS	1075.	94.	246.	283.	263.	189.
	MASS INDEX	0.02	0.00	0.00	0.00	0.00	0.00
	PINDEX	0.02	0.00	0.01	0.01	0.00	0.00
	POPEX	0.01					

TABLE X. CONTINUED.

SOURCE CATEGORY		TOTAL	PM	SO2	NOX	CO	HC
857	EMISSIONS	1977.	245.	1061.	637.	2.	32.
	MASS INDEX	0.03	0.00	0.02	0.01	0.00	0.00
	PINDEX	0.07	0.01	0.04	0.02	0.00	0.00
	POPEX	0.03					
858	EMISSIONS	21174.	44.	27.	988.	17010.	3105.
	MASS INDEX	0.33	0.00	0.00	0.02	0.27	0.05
	PINDEX	0.09	0.00	0.00	0.03	0.01	0.05
	POPEX	0.11					
859	EMISSIONS	31946.	0.	0.	0.	0.	31946.
	MASS INDEX	0.50	0.0	0.0	0.0	0.0	0.50
	PINDEX	0.51	0.0	0.0	0.0	0.0	0.51
	POPEX	0.83					
861	EMISSIONS	184118.	0.	0.	0.	0.	184118.
	MASS INDEX	2.89	0.0	0.0	0.0	0.0	2.89
	PINDEX	2.94	0.0	0.0	0.0	0.0	2.94
	POPEX	3.48					

TABLE XI. CHICAGO AQCR SOURCE-CATEGORIES IN THE DECREASING ORDER OF PUPEX.

SOURCE CATEGORY	SOURCE-CATEGORY NAME	PERCENT CONTRIBUTION TO INDICES[1] MI	PI	PO	RANKINGS MI	PI	PO
845	TRA GASOLIN LIGHT VEHI	34.	12.	23.	1	1	1
828	EXT INDUSTR BITUMINOUS	3.6	8.1	12.	1	1	1
822	EXT RESIDEN BITUMINOUS	2.2	3.1	5.5	1	1	1
861	MIS SOLVENT LOSS	2.9	2.9	5.5	1	1	1
9	EXT ELEC GEN BITUMINOU G100MMBTU PU	5.0	13.	4.5	1	1	1
10	EXT ELEC GEN BITUMINOU G100MMBTU CY	2.7	6.7	3.6	1	1	1
835	EXT COMM/IN RESIDUAL O	.74	1.7	2.8	2	1	1
823	EXT RESIDEN DISTILLATE	.77	1.7	2.8	2	1	1
849	TRA DIESEL HEAVY VEHI	1.2	1.5	2.8	1	1	1
847	TRA GASOLIN HEAVY VEHI	4.6	1.9	2.7	1	1	1
66	EXT INDUST BITUMINOU G100MMBTU PU	1.9	4.5	2.3	1	1	1
617	IND MINERA STONE QUA CUT STONE-G	.73	1.4	2.3	2	1	1
844	SOL INDUSTR ON SITE IN	1.3	1.2	1.9	1	1	1
845	SOL INDUSTR OPEN BURNI	2.0	1.2	1.9	1	1	1
595	IND MINERA LIME MFG CALCINNG-RD	.41	.80	1.3	2	2	1
745	PSL SURFA LAQUER GENERAL	.60	.61	1.1	2	2	1
851	TRA DIESEL RAIL	.82	.76	1.1	2	2	1
658	IND PETROL OTHER/NOT SPECIFY IN	.62	1.3	.96	2	1	2
831	EXT INDUSTR NATURAL GA	.33	.56	.65	2	2	2
427	IND PRIMAR IRON PROD SINTERING G	3.6	1.2	.83	1	1	2
859	TRA GASOLIN DLING EVAP	.40	.51	.63	2	2	2
105	EXT INDUST PROCESS G G100MMBTU/HR	1.0	2.2	.78	1	1	2
96	EXT INDUST RESIDUAL G100MMBTU/HR	.94	2.3	.71	2	1	2
854	TRA AIR COMMERCIAL	.50	.32	.65	2	2	2
65	EXT INDUST BITUMINOU G100MMBTU PU	.24	.55	.61	2	2	2
829	EXT INDUSTR RESIDUAL O	.16	.37	.61	2	2	2
840	SOL RESIDEN ON SITE IN	1.3	.55	.60	1	2	2
108	EXT INDUST COKE 10-100MMBTU	.40	.99	.59	2	2	2
825	EXT RESIDEN NATURAL GA	.24	.36	.56	2	2	2
637	IND PETROL FLUID CRA GENERAL (F	5.7	.73	.54	1	2	2
761	SW GOVERN MUNICIPAL MULTIPLE CH	.41	.39	.52	2	2	2
528	IND MINERA ASPHALTIC OTHER SOURC	.14	.27	.47	2	2	2
8	EXT ELEC GEN BITUMINOU G100MMBTU PU	.48	1.2	.46	2	1	2
657	IND PETROL OTHER/NOT SPECIFY IN	3.2	1.7	.43	1	1	2

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[1] MI-MASS INDEX, PI-PINDEX, PO-PUPEX

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TABLE XI. CONTINUED.

SOURCE CATEGORY	SOURCE-CATEGORY NAME	PERCENT CONTRIBUTION TO INDICES[1] MI	PI	PO	RANKINGS MI	FI	PO
35	EXT ELEC GEN RESIDUAL G100MMBTU/HR	.43	1.0	.43	2	1	2
63	EXT INDUST BITUMINOU G100MMBTU SP	.34	.81	.43	2	2	2
830	EXT INDUSTR DISTILLATE	.11	.25	.39	2	2	2
42	EXT ELEC GEN NATURAL G G100MMBTU/HR	.35	.67	.39	2	2	2
749	PSE PETRO FIXED ROO BREATHING-P	.92	.98	.37	2	2	2
73	EXT INDUST BITUMINOU 10-100MMBTU	.42	.95	.34	2	2	2
97	EXT INDUST RESIDUAL 10-100MMBTU	.28	.63	.33	2	2	2
399	IND PRIMAR COKE MET TGENERAL	.89	1.1	.33	2	1	2
743	PSE SURFA PAINT GENERAL	.22	.22	.33	2	2	2
436	IND PRIMAR STEEL PRO ELECT ARC W	1.3	.90	.32	1	2	2
495	IND SECOND LEAD SMEL REVERB FNC	.67E-01	.17	.32	3	2	2
405	IND PRIMAR COKE-MET OTHER/NOT C	.27	.70	.31	2	2	2
841	SOL RESIDEN OPEN BURNI	.34	.20	.30	2	2	2
838	EXT COMM/IN NATURAL GA	.11	.18	.28	2	2	2
434	IND PRIMAR STEEL PRO OPENHEARTH N	.36	.73	.27	2	2	2
751	PSE PETRO FIXED ROO WORKING-PRO	.67	.68	.25	2	2	2
633	IND PETROL PROCESS H OIL	.40	.99	.26	2	2	2
850	TRA DIESEL OFF HIGHWA	.15	.20	.26	2	2	2
349	IND FOOD/A FEED/GRAI SHIPNG/RECE	.58E-01	.11	.23	3	2	2
796	SW INDUST INCINERAT SINGLE CHAM	.13	.21	.22	2	2	2
632	IND MINERA OTHER/NOT SPECIFY IN	.52E-01	.10	.21	3	2	2
79	EXT INDUST BITUMINOU OTHER/NOT C	.54E-01	.12	.20	3	2	2
400	IND PRIMAR COKE-MET OVEN CHARGI	.40	.50	.20	2	2	2
737	IND OTHER/ SPECIFY I	.12	.22	.18	2	2	2
306	TRA GASOLIN OFF HIGHWA	1.1	.33	.17	1	2	2
72	EXT INDUST BITUMINOU 10-100MMBTU	.32	.72	.16	2	2	2
70	EXT INDUST BITUMINOU 10-100MMBTU	.49E-01	.11	.16	3	2	2
45	EXT ELEC GEN PROCESS G G100MMBTU/HR	.58	1.2	.15	2	1	2
634	IND PETROL PROCESS H GAS	.15	.37	.14	2	2	2
130	EXT COMMER BITUMINOU 10-100MMBTU	.24	.53	.14	2	2	2
740	PSE SURFA ENAMEL GENERAL	.72E-01	.73E-01	.13	3	3	2
612	IND MINERA STONE QUA TERT CRUSH/	.25	.56	.12	2	2	2
732	SW COMM-I OPEN BURN WOOD	.70E-01	.42E-01	.11	3	3	2
477	IND SECOND GRAY IRON CUPOLA	.49	.48E-01	.11	2	3	2

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[1] MI-MASS INDEX. PI-PINDEX. PO-POPEX

TABLE XI. CONTINUED.

SOURCE CATEGORY	SOURCE-CATEGORY NAME	PERCENT CONTRIBUTION TO INDICES[1] MI	PI	PO	RANKINGS MI	PI	PO
858	TRA VESSELS GASOLINE	.33	.93E-01	.11	2	3	2
843	SOL COMM/IN OPEN BURNI	.11	.67E-01	.10	2	3	2
551	IND MINERA CEMENT MF KILNS-COAL	.15	.34	.10	2	2	3
205	IND CHEM MFG CLEANING SOAP/DET SP	.26E-01	.51E-01	.97E-01	3	3	3
616	IND MINERA STONE QUA OPEN STORAG	.27	.53	.97E-01	2	2	3
762	SW GOVERN MUNICIPAL SINGLE CHAM	.65E-01	.60E-01	.89E-01	3	3	3
98	EXT INDUST RESIDUAL L10MMBTU/HR	.31E-01	.73E-01	.89E-01	3	3	3
402	IND PRIMAR COKE-MET QUENCHING	.96E-01	.17	.86E-01	3	2	3
747	PSE SURFA [illegible] [illegible]	.80E-01	.59E-01	.85E-01	3	3	3
547	IND MINERA CEMENT MF KILNS	.22E-01	.43E-01	.82E-01	3	3	3
531	IND MINERA BRICK MAN GRINDING-RA	.24E-01	.48E-01	.81E-01	3	3	3
103	EXT INDUST NATURAL G 10-100MMBTU	.93E-01	.16	.80E-01	3	2	3
495	IND SECOND STEEL FOU OPEN HEARTH	.45E-01	.89E-01	.74E-01	3	3	3
350	IND FOOD/A FEED/GRAI TRANSFER/CO	.12E-01	.34E-01	.69E-01	3	3	3
401	IND PRIMAR COKE-MET OVEN PUSHIN	.98E-01	.16	.67E-01	3	2	3
835	EXT COMM/IN BITUMINOUS	.81E-01	.18	.67E-01	3	2	3
435	IND PRIMAR STEEL [illegible] [illegible]	.2[illegible]	.11	.64E-01	2	2	3
530	IND MINERA BRICK MAN DRYING-RAW	.16E-01	.31E-01	.63E-01	3	3	3
104	EXT INDUST NATURAL G L10MMBTU/HR	.34E-01	.61E-01	.62E-01	3	3	3
615	IND MINERA STONE QUA SCREEN/CONV	.64E-01	.13	.52E-01	3	2	3
305	IND CHEM MFG FERTILIZ- DRYER-COOLE	.14E-01	.31E-01	.50E-01	3	3	3
256	IND CHEM MFG H2SO4-CON OTHER/NOT C	.92E-01	.24	.49E-01	3	2	3
257	IND CHEM MFG H2SO4-CON 99.0 CONVER	.7[illegible]E-01	.20	.49E-01	3	2	3
842	SOL COMM/IN ON SITE IN	.77E-01	.44E-01	.48E-01	3	3	3
333	IND CHEM MFG [illegible] SPECIFY IN	.2[illegible]E-01	.29E-01	.43E-01	3	3	3
474	IND SECOND BRASS/BRO REVERB FNC	.12E-01	.24E-01	.42E-01	3	3	3
692	IND METAL IRON/STEE OTHER/NOT C	.10E-01	.20E-01	.41E-01	3	3	3
106	EXT INDUST PROCESS G 10-100MMBTU	.62E-01	.15	.41E-01	3	2	3
331	IND FOOD/A FEED/GRAI SCREENING/C	.10E-01	.20E-01	.40E-01	3	3	3
527	IND MINERA ASPHALTIC ROTARY DRYE	.15E-01	.31E-01	.40E-01	3	3	3
147	EXT COMMER RESIDUAL G100MMBTU/HR	.82E-02	.14E-01	.40E-01	4	3	3
638	IND PETROL MOV-BED C GENERAL (T	.80E-01	.16	.40E-01	3	2	3
208	IND CHEM MFG EXPLOSIVE NITRATION R	.11	.22	.39E-01	2	2	3
952	TRA AIR MILITARY	.21E-01	.19E-01	.35E-01	3	3	3

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[1] MI-MASS INDEX, PI-PINDEX, PO-POPEX

TABLE XI. CONTINUED.

SOURCE CATEGORY	SOURCE-CATEGORY NAME	PERCENT CONTRIBUTION TO INDICES[1] MI	PI	PC	RANKINGS MI	PI	PC
592	IND MINERA LIME MFG PRIMARY CRU	.93E-01	.10	.32E-01	3	2	3
548	IND MINERA CEMENT MF DRYERS/GRIN	.85E-02	.17E-01	.32E-01	4	3	3
758	PSE MISC OTHER/NOT SPECIFY IN	.14E-01	.14E-01	.30E-01	3	3	3
102	EXT INDUST NATURAL G GT100MMBTU/HR	.36E-01	.68E-01	.30E-01	3	3	3
429	IND PRIMAR IRON PROD SCARFING	.34E-01	.38E-01	.29E-01	3	3	3
937	EXT COMM/IN DISTILLATE	.35E-01	.77E-01	.26E-01	3	3	3
657	TRA VESSELS RESIDUAL O	.31E-01	.71E-01	.27E-01	3	3	3
244	IND CHEM MFG PLASTICS PVC-GENERAL	.65E-02	.13E-01	.25E-01	4	3	3
11	EXT ELEC GEN BITUMINOU GT100MMBTU SP	.17E-01	.23E-01	.25E-01	3	3	3
151	EXT COMMER DISTILLAT 10-100MMBTU	.42E-02	.92E-02	.25E-01	4	4	3
463	IND SECOND ALUMINUM SMELT-REVER	.62E-02	.16E-01	.25E-01	4	3	3
305	IND CHEM MFG FERTILIZ- AMONIAT-GRA	.63E-02	.12E-01	.25E-01	4	3	3
181	IND CHEM MFG AMMONIA W PURGE GAS	.12E-01	.12E-01	.24E-01	3	3	3
853	TRA AIR CIVIL	.50E-01	.15E-01	.24E-01	3	3	3
352	IND FOOD/A FEED/GRAI DRYING	.64E-02	.13E-01	.22E-01	4	3	3
611	IND MINERA STONE QUA SEC CRUSH/S	.55E-01	.11	.21E-01	3	2	3
744	PSE SURFA VARNISH/S GENERAL	.90E-02	.92E-02	.18E-01	4	4	3
263	IND CHEM MFG H2SO4-CON 97.0 CONVER	.39E-01	.99E-01	.18E-01	3	3	3
471	IND SECOND BRASS/BRO CRUCIBLE FN	.47E-02	.93E-02	.17E-01	4	4	3
99	EXT INDUST DISTILLAT GT100MMBTU/HR	.23E-01	.55E-01	.14E-01	3	3	3
750	PSE MISC OTHER/NOT SPECIFY IN	.75E-02	.76E-02	.14E-01	4	4	3
211	IND CHEM MFG EXPLOSIVE RED WATER I	.38E-01	.80E-01	.14E-01	3	3	3
132	EXT COMMER DISTILLAT LT10MMBTU/HR	.21E-01	.49E-01	.13E-01	3	3	3
475	IND SECOND BRASS/BRO ROTARY FNC	.37E-02	.72E-02	.13E-01	4	4	3
856	TRA VESSELS DIESEL FUE	.17E-01	.25E-01	.13E-01	3	3	3
389	IND FOOD/A OTHER/NOT SPECIFY IN	.34E-02	.66E-02	.13E-01	4	4	3
520	IND SECOND MISC CAST SPECIFY IN	.33E-02	.65E-02	.12E-01	4	4	3
221	IND CHEM MFG NITRIC AC AMMONIAOXID	.36E-01	.72E-01	.12E-01	3	3	3
179	IND CHEM MFG ADIPIC AC GENERAL-CYC	.31E-02	.63E-02	.12E-01	4	4	3
247	IND CHEM MFG PLASTICS OTHER/NOT C	.34E-02	.67E-02	.12E-01	4	4	3
642	IND PETROL PROCESS O GEN W/O CON	.51E-01	.52E-01	.12E-01	3	3	3
426	IND PRIMAR IRON PROD BLAST FNC-A	.12E-01	.23E-01	.12E-01	3	3	3
425	IND PRIMAR IRON PROD BLAST FNC-O	.16E-01	.79E-02	.12E-01	3	4	3
731	IND INPROC PROCESS G OTHER/NOT C	.33E-02	.74E-02	.11E-01	4	4	3

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[1] MI=MASS INDEX, PI=PINDEX, PC=POPEX

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TABLE XI. CONTINUED.

SOURCE CATEGORY	SOURCE-CATEGORY NAME	PERCENT CONTRIBUTION TO INDICES[1] MI	PI	PC	RANKINGS MI	PI	PD
593	IND METAL PLATING O OTHER/NOT C	.31E-02	.61E-02	.11E-01	4	4	3
230	IND CHEM MFG PAINT MFG GENERAL	.48E-02	.51E-02	.11E-01	4	4	3
361	IND FOOD/A GRAIN PRO OTHER/NOT C	.15E-01	.30E-01	.10E-01	3	3	3
438	IND PRIMAR STEEL PRO OTHER/NOT C	.25E-02	.51E-02	.10E-01	4	4	3
301	IND CHEM MFG FERTILIZ- GRIND-DRY	.27E-02	.53E-02	.93E-02	4	4	4
645	IND PETROL COOLING T	.47E-01	.48E-01	.91E-02	3	3	4
610	IND MINERA STONE QUA PRIMARY CRU	.24E-01	.47E-01	.90E-02	3	3	4
249	IND CHEM MFG PRINTING COOKING-GEN	.41E-02	.42E-02	.86E-02	4	4	4
118	EXT INDUST OTHER/NOT SPECIFY IN	.13E-01	.33E-01	.84E-02	3	3	4
582	IND MINERA GLASS MFG SODALIME GE	.40E-02	.78E-02	.83E-02	4	4	4
148	EXT COMMER RESIDUAL 10-100MMBTU	.14E-02	.30E-02	.82E-02	4	4	4
154	EXT COMMER NATURAL G 10-100MMBTU	.21E-02	.36E-02	.80E-02	4	4	4
752	PSE PETRO FIXED ROO WORKING CRO	.35E-01	.36E-01	.68E-02	3	3	4
210	IND CHEM MFG EXPLOSIVE H2SO4 REGEN	.12E-01	.32E-01	.58E-02	3	3	4
522	IND MINERA ASPHALT R BLOWING OPE	.15E-01	.17E-01	.57E-02	3	3	4
262	IND CHEM MFG H2SO4-CON 98.0 CONVER	.13E-01	.34E-01	.54E-02	3	3	4
433	IND PRIMAR STEEL PRO OPNHEARTH O	.67E-02	.15E-01	.54E-02	4	3	4
499	IND SECOND STEEL FOU OTHER/NOT C	.25E-02	.26E-02	.52E-02	4	4	4
476	IND SECOND BRASS/BRO OTHER/NOT C	.14E-02	.28E-02	.52E-02	4	4	4
550	IND MINERA CERAMIC/C GRINDING	.47E-01	.93E-01	.52E-02	3	3	4
149	EXT COMMER RESIDUAL L10MMBTU/HR	.14E-02	.26E-02	.51E-02	4	4	4
750	PSE PETRO FIXED ROO BREATHING C	.30E-01	.31E-01	.50E-02	3	3	4
614	IND MINERA STONE QUA FINES MILL	.14E-01	.28E-01	.49E-02	3	3	4
437	IND PRIMAR STEEL PRO ELECT ARC N	.18E-02	.35E-02	.47E-02	4	4	4
101	EXT INDUST DISTILLAT L10MMBTU/HR	.35E-02	.80E-02	.42E-02	4	4	4
234	IND CHEM MFG VARNISH M OLEORESINOU	.21E-02	.21E-02	.41E-02	4	4	4
128	EXT COMMER BITUMINOU 10-100MMBTU	.11E-01	.26E-01	.37E-02	3	3	4
136	EXT COMMER BITUMINOU OTHER/NOT C	.11E-01	.24E-01	.36E-02	3	3	4
494	IND SECOND STEEL FOU ELECTRIC AR	.13E-02	.26E-02	.35E-02	4	4	4
346	IND FOOD/A FEED/GRAI TRANSFER/CO	.88E-03	.17E-02	.33E-02	5	4	4
714	IND INPROC RESIDUAL OTHER/NOT C	.30E-02	.54E-02	.29E-02	4	4	4
795	SW INDUST INCINERAT MULTIPLE CH	.47E-02	.55E-02	.29E-02	4	4	4
472	IND SECOND BRASS/BRO CUPOLA FNC	.46E-03	.19E-02	.28E-02	5	4	4
379	IND FOOD/A STARCH MF GENERAL	.66E-03	.13E-02	.25E-02	5	4	4

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[1] MI=MASS INDEX, PI=PINDEX, PC=POPEX

TABLE XI. CONTINUED.

SOURCE CATEGORY	SOURCE-CATEGORY NAME	PERCENT CONTRIBUTION TO INDICES[1] MI	PI	PO	RANKINGS MI	PI	PO
500	IND SECOND ZINC SEC RETORT FNC	.64E-03	.13E-02	.23E-02	5	4	4
135	EXT COMMER BITUMINOU L10MMBTU HAN	.56E-03	.81E-03	.22E-02	5	5	4
778	SW COMM-I INCINERAT SINGLE CHAM	.13E-02	.14E-02	.22E-02	4	4	4
183	IND CHEM MFG AMMONIA W REGENERATOR	.25E-01	.93E-03	.18E-02	3	5	4
739	PSE CLEAN DRYCLEANI STODDARD	.73E-02	.75E-02	.16E-02	4	4	4
783	SW COMM-I APARTMENT FLUE FED	.49E-03	.59E-03	.16E-02	5	5	4
541	IND MINERA CASTABLE RAWMATL DRY	.20E-02	.40E-02	.16E-02	4	4	4
112	EXT INDUST LIQ PETRO 10-100MMBTU	.22E-02	.53E-02	.15E-02	4	4	4
347	IND FOOD/A FEED/GRAI SCREENING/C	.41E-03	.80E-03	.15E-02	5	5	4
559	IND MINERA CERAMIC/C DRYING	.13E-01	.26E-01	.15E-02	3	3	4
646	IND PETROL MISCELLAN PIPE/VALVE-	.61E-02	.62E-02	.14E-02	4	4	4
589	IND MINERA GYPSUM MF CALCINER	.24E-02	.48E-02	.14E-02	4	4	4
593	IND MINERA LIME MFG SECNDRY CRU	.11E-01	.22E-01	.11E-02	3	3	4
826	EXT RESIDEN WOOD	.58E-03	.11E-02	.11E-02	5	4	4
523	IND MINERA ASPHALT R DIPPING CNL	.24E-02	.48E-02	.10E-02	4	4	4
741	PSE CLEAN DEGREASIN OTHER/NOT C	.11E-01	.11E-01	.97E-03	3	3	5
648	IND PETROL MISCELLAN PUMP SEALS	.37E-02	.38E-02	.86E-03	4	4	5
650	IND PETROL MISCELLAN OTHER-GENL	.20E-02	.20E-02	.79E-03	4	4	5
100	EXT INDUST DISTILLAT 10-100MMBTU	.97E-03	.23E-02	.77E-03	5	4	5
479	IND SECOND GRAY IRON ELECT INDUC	.25E-03	.49E-03	.72E-03	5	5	5
504	IND SECOND ZINC SEC GALVANIZING	.17E-03	.34E-03	.68E-03	5	5	5
524	IND MINERA ASPHALT R SPRAYING CN	.14E-03	.28E-03	.64E-03	5	5	5
37	EXT ELEC GEN RESIDUAL 10-100MMBTU	.15E-02	.37E-02	.64E-03	4	4	5
546	IND MINERA CASTABLE OTHER/NOT C	.77E-03	.15E-02	.62E-03	5	4	5
153	EXT COMMER NATURAL G G100MMBTU/HR	.69E-03	.13E-02	.61E-03	5	4	5
651	IND PETROL FLARES NATURAL GAS	.19E-03	.49E-03	.57E-03	5	5	5
730	IND INPROC NATURAL G OTHER/NOT C	.13E-03	.30E-03	.56E-03	5	5	5
821	EXT RESIDEN ANTHRACITE	.21E-02	.15E-02	.55E-03	4	4	5
354	IND FOOD/A GRAIN PRO CORN MEAL	[illegible]	.17E-02	.54E-03	5	4	5
525	IND MINERA ASPHALT R DIPPING/SPR	.61E-03	.60E-03	.54E-03	5	5	5
677	IND WOOD P PULPBOARD FIBERBOARD-	.13E-03	.25E-03	.48E-03	5	5	5
647	IND PETROL MISCELLAN VESL RELIEF	.24E-02	.24E-02	.46E-03	4	4	5
77	EXT INDUST BITUMINOU L10MMBTU SPD	.12E-02	.24E-02	.44E-03	4	4	5
110	EXT INDUST WOOD WOOD WASTE	.49E-03	.89E-03	.38E-03	5	5	5

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[1] MI-MASS INDEX, PI-PINDEX, PO-POPEX

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TABLE XI. CONTINUED.

SOURCE CATEGORY	SOURCE-CATEGORY NAME	PERCENT CONTRIBUTION TO INDICES[1] MI	PI	PC	RANKINGS MI	PI	PO
478	IND SECOND GRAY IRON REVERB FNC	.11E-03	.22E-03	.37E-03	5	5	5
706	IND INPROC BITUMINOU OTHER/NOT C	.24E-03	.61E-03	.36E-03	5	5	5
605	IND MINERA PHOSPHATE DRYING	.66E-03	.13E-02	.35E-03	5	4	5
345	IND FOOD/A FEED/GRAI SHIPING/REC	.28E-03	.55E-03	.33E-03	5	5	5
748	PSE SURFA OTHER/NOT SPECIFY IN	.45E-02	.46E-02	.26E-03	4	4	5
533	IND MINERA BRICK MAN CURING GAS	.44E-03	.74E-03	.26E-03	5	5	5
639	IND PETROL BLOW-DOWN W/CONTROLS	.11E-02	.11E-02	.24E-03	4	4	5
209	IND CHEM MFG EXPLOSIVE HNO3 CONC	.69E-03	.14E-02	.24E-03	5	4	5
43	EXT ELEC GEN NATURAL G 10-100MMBTU	.71E-03	.13E-02	.23E-03	5	4	5
649	IND PETROL MISCELLAN COMPRESR SE	.11E-02	.11E-02	.22E-03	4	4	5
111	EXT INDUST WOOD SMALL HANDF	.33E-03	.61E-03	.20E-03	5	5	5
591	IND MINERA GYPSUM MF OTHER/NOT C	.31E-03	.62E-03	.18E-03	5	5	5
502	IND SECOND ZINC SEC POT FURNACE	.47E-04	.92E-04	.18E-03	5	5	5
237	IND CHEM MFG VARNISH M OTHER/NOT C	.53E-03	.54E-03	.15E-03	5	5	5
579	IND MINERA FIBERGLAS OTHER/NOT C	.12E-02	.13E-02	.13E-03	4	4	5
802	SW INDUST OPEN BURN REFUSE	.16E-03	.18E-03	.11E-03	5	5	5
39	EXT ELEC GEN DISTILLAT <100MMBTU/HR	.71E-03	.12E-02	.99E-04	5	4	5
590	IND MINERA GYPSUM MF CONVEYING	.16E-03	.31E-03	.90E-04	5	5	5
797	SW INDUST INCINERAT CONTROLLED	.27E-03	.55E-03	.85E-04	5	5	5
495	IND SECOND STEEL FOU INDUCTION F	.94E-04	.18E-03	.64E-04	5	5	5
440	IND PRIMAR LEAD SMEL BLAST FURNA	.11E-03	.22E-03	.60E-04	5	5	5
473	IND SECOND BRASS/BRO ELECT INDUC	.94E-04	.18E-03	.35E-04	5	5	5
544	IND MINERA CASTABLE CURING OVEN	.31E-04	.62E-04	.21E-04	5	5	5

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[1] MI-MASS INDEX, PI-PINDEX, PO-POPEX

TABLE XII. ASSIGNMENT OF RANKS BASED ON PERCENT CONTRIBUTIONS OF EACH OF THE SOURCE-CATEGORIES TO POPEX, PINDEX, AND MASS INDEX

Range of Percentages	Rank
Index[1] ≤ 1.0	1
$0.1 \leq$ Index < 1.0	2
$0.01 \leq$ Index < 0.1	3
$0.001 \leq$ Index < 0.01	4
Index < 0.001	5

[1] Value of popex, pindex or mass index

Thus, the assignment of ranks is based on the order of magnitude of percent contribution to each index. A source-category having a contribution equivalent to the average of all categories, or 0.44 (100 divided into 227 source-categories) has a rank of 2. The source-category representing a median popex contribution of 0.025 (source-category 463) has a rank of 3.

Table XIII which was derived from Table XI shows the number of point and area source-categories and their contribution to popex for each of the rank groups.

RESULTS

General Observations

It should be evident from the construction of popex and its submodels that the results of popex estimate specific source-related air pollution problems in terms of the impact on people. Sources in the first rank-group contribute most to the popex on a percent basis

TABLE XIII. POPEX RANK-GROUPS

Rank	Number of source-categories				Percent contribution to popex			
	Point	Area	Total	Cumulative total	Point	Area	Total	Cumulative total
1	6	11	17	17	15.05	62.27	77.32	77.32
2	40	13	53	70	14.05	5.71	19.76	97.08
3	63	7	70	140	2.50	0.21	2.71	99.79
4	44	1	45	185	0.189	0.001	0.19	99.98
5	41	1	42	227	0.0155	0.0005	0.016	100.00

(Table XIII). Seventeen source-categories of rank one are responsible for over three-fourths of the total popex, or three-fourths of air-pollution-population-effect problem. Thus, a reduction by 50 percent in the popex of the 17 source-categories of rank one would reduce the total popex level by over one-third. On the other hand, even complete elimination of the 87 source-categories of ranks 4 and 5 would hardly be noticeable. It should be pointed out that this phenomenon of a few source-categories contributing most, if not all, of the air pollution problem is not unique to popex rankings. From Table XI it can be seen that even in mass index or pindex, the source-categories of rank 1, as defined by the respective indices, are responsible for over 70 percent of the index level.

Area sources also tend to dominate the total as compared to point sources (Table XIII): 194 point source-categories contribute 32 percent of popex whereas 33 area source-categories are responsible for 68 percent of popex. It should be kept in mind that the classification of the point source-categories is on a much more detailed basis than the area source-categories. For example, there are 15 different categories for external-combustion-industrial point sources burning bituminous coal, but all of the area sources, similarly characterized, are included in only a single category. Similarly, emissions from all types of automobiles are lumped into one area source-category, but there are ten different categories for manufacturing sulfuric acid. Eight of these sulfuric acid manufacturing categories are differentiated only on the basis of variation in conversion efficiency between 93 to 99.7 percent. Finally, since the area source-categories tend to be large, all except two are included in the first three popex rank-groups.

In the following section, the source-categories included in the popex-rank-group one are discussed in detail. Source-categories of the rank-group two are enumerated later in this chapter.

Discussion of Sources of the Popex-Rank-Group One

Seventeen out of a total of 227 source-categories each contribute more than one percent to popex (Table XIII). Table XIV shows these categories along with their popex levels. The first six categories are point sources and the rest are area sources. In the point source categories of rank one, there are only three basic source types: (1) large boilers using bituminous coal, (2) mineral product industries involving lime manufacture and stone-blasting operations, and (3) solvent evaporation. Similarly, area source-categories of rank one could be classified into four subgroups: (4) external combustion, (5) solid waste disposal, (6) transportation, and (7) solvent evaporation.

The first three subgroups of point source-categories are summarized in Table XV and are discussed below in detail. Since each area source-category comprises a large number of small sources, similar information on individual area sources is not available. A generalized discussion of the area sources in rank-group one follows the discussion on point sources.

(1) Large external combustion boilers. - The first subgroup of sources consists of large bituminous coal fired industrial and electric utility

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TABLE XIV. SOURCE-CATEGORIES IN POPEX - PAH - GROUP ONE

Source category[1]	Source classification code[1]	Name of the source-category	Popex	Popex for each subgroup
9	1-01-002-02	External combustion boiler - electric generation - bituminous coal - >100 MMBTU pulv dry	4.45	
10	1-01-002-03	External combustion boiler - electric generation - bituminous coal - >100 MMBTU cyclone	3.59	10.34 (Subgroup 1)
66	1-02-002-02	External combustion boiler - industrial - bituminous coal - >100 MMBTU pulv dry	2.30	
595	3-05-016-04	Industrial process - mineral products - lime manufacturing - calcining-rotary kiln	1.28	3.57 (Subgroup 2)
617	3-05-020-06	Industrial process - mineral products - stone quarry processing - cut stone-general	2.29	
745	4-03-004-01	Point-source evaporation - surface coating lacquer - general	1.14	1.14 (Subgroup 3)

TABLE XIV. CONTINUED

Source category[1]	Source classification code[1]	Name of the source-category	Popex	Popex for each subgroup
822	Area source	External combustion - residential - bituminous coal	5.49	
823	Area source	External combustion - residential - distillate oil	2.78	23.56 (Subgroup 4)
826	Area source	External combustion - industrial - bituminous coal	12.48	
836	Area source	External combustion - commerical - institutional - residual oil	2.81	
844	Area source	Solid waste disposal - industrial - on site incineration	1.90	3.77 (Subgroup 5)
845	Area source	Solid waste disposal - industrial - open burning	1.87	

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TABLE XIV. CONTINUED

Source category[1]	Source classification code[1]	Name of the source-category	Popex	Popex for each subgroup
846	Area source	Transportation - land vehicles - gasoline light vehicles	[illegible]	
847	Area source	Transportation - land vehicles - gasoline heavy vehicles	[illegible]	29.45
848	Area source	Transportation - land vehicles - diesel heavy vehicles	[illegible]	(Subgroup 6)
[illegible]	Area source	Transportation - land vehicles - diesel rail	1.12	
861	Area source	Miscellaneous - solvent evaporation loss	5.48	5.48 (Subgroup 7)

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[1] See Appendix C.

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TABLE XV. SUMMARY TABLE FOR POINT SOURCES IN POPEX - RANK - GROUP ONE

Subgroup[1]	Source-category number	Number of sources in each county	Major emissions	Height of stack (ft.)	Control devices (control efficiency, percent)	Emission factor rating[2]	Ratio of emissions US/Chicago
1. External combustion - large boilers (>10^6 BTU/hr) using bituminous coal	9	3-Cook 3-Lake, Ill. 6-Will 15-Lake, Ind.	SO_2, NO_x, PM	225-530	Electrostatic precipitator (90-98) High efficiency wet scrubbers (98-99)	A	1.6
	10	7-Cook 2-Lake, Ill. 5-Will 2-Porter	SO_2, NO_x	200-400	Electrostatic precipitator (98) High efficiency scrubbers	A	1.6
	66	3-Cook 1-Grundy 1-Will 12-Lake, Ind.	SO_2, PM, NO_x	0 - 200	No control equip. or Centrifugal collector (85) low efficiency fabric filter (99)	A	1.6
2. Mineral-product industries, such as lime manufacturing, stone quarrying	595	6-Cook	PM (only)	45-75	Fabric filters (99.5) Wet scrubbers (99+)	A	1.4

TABLE XV. CONTINUED

Subgroup[1]	Source-category number	Number of sources in each county	Major emissions	Height of stack (ft.)	Control devices (control efficiency, percent)	Emission factor rating[2]	Ratio of emissions US/Chicago
	617	4-Cook	PM (only)	75	Largest source does not have any control equip. Some of smaller sources have centrifugal collectors (70) or fabric filters (99).	C	1.4
3. Point source evaporation	745	5-Cook 1-Kane	HC (only)	No stacks, estimated plume ht. 20 ft.	No control equipment	B	0.6

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[1] From Table XIV

[2] Based on U. S. Environmental Protection Agency (24)

boilers. Source-categories 9 and 10 are electricity generation boilers which use pulverized coal. Source-category 10 uses cyclone furnaces and has a low emission factor for particulates (24). Most of the sources in categories 9 and 10 have high efficiency control equipment and tall stacks (over 200 feet).

Source-category 66 is for industrial boilers and, although this category, like categories 9 and 10, is also for boilers having greater than 100 million BTU/hr as a design capacity; the boilers in category 66 are generally smaller. Capacities of the boilers in category 66 range from 2 to 20 tons of coal per hour as compared to at least 50 ton per hour and quite often in excess of 100 tons, as in the case of categories 9 and 10. On the other hand, quite often the load factor for industrial boilers is greater than that for the electric utility boilers. Approximately one-half the total number of industrial boilers use no control equipment while others use low efficiency fabric filters or centrifugal collectors. Stack heights for these boilers are generally lower than that of the utility boilers (categories 9 and 10). Thus, in the case of industrial boilers, a combination of the factors: higher load factor, lower efficiency control equipment, and low stacks, results in a popex level which is comparable to that of the much larger capacity electric utility boilers.

The emission factors ratings (24) for all of the source-categories in this group are "A" which means that emissions data are most precise. From Table II, the ratio of total U. S. to Chicago AQCR emissions is

1.6. Thus, in a nationwide rating this group of sources could rank even higher.

Control technologies for elimination or reduction of SO_2 and NO_x emissions are under development (48). In case of SO_2, the efforts of Industrial Environmental Research Laboratory, IERL (previously Control Systems Laboratory, CSL) of EPA have accelerated the development of flue gas cleaning technology which is now in the process of commercialization. The early efforts of the IERL were directed towards development of lime/limestone scrubbing processes and the present efforts are directed towards increasing process reliability and lowering costs (48). Other methods for flue gas cleaning under development through the IERL include magnesium oxide, catalytic oxidation, sodium ion scrubbing with thermal regeneration, etc.

In the case of NO_x emissions, the technology is not as advanced as for SO_2 removal. Efforts directed by IERL include combustion modification to prevent NO_x formation and flue gas cleaning to control NO_x emissions. Completion of major development efforts is not expected before 1980 (48).

(2) Mineral products processing industries. - This subgroup includes two source-categories: (a) manufacture of lime using rotary kilns, and (b) stone quarrying operations. All the sources in this subgroup have emissions of particulates only.

In the manufacture of lime, rotary kilns have much higher emissions (200 lb/ton processed) as compared to vertical kilns (8 lb/ton processed).

However, all six sources in the category (number 595) have moderate to high efficiency control equipment and are located in densely populated Cook County. An emission factor rating of B indicates the emissions data are fairly accurate.

Among the four sources in the second source-category related to stone-quarrying operations, the largest source processing over 4.5 million tons/year did not have any control equipment. This may be one of the important reasons why this category has ranked so high in the priority listings. The other three sources in this source-category (number 617) process 25,000 to 60,000 tons/year and have low to moderate efficiency control equipment. This category of sources has an emission factor rating of C, which indicates that emission data may not be very accurate. Thus, with improved emissions data, this category may or may not have a popex rank of one.

This group of sources involving mineral product processing industries has nationwide emissions of 2.9 percent as compared to 2.1 percent in the Chicago AQCR. Thus, this category could rank somewhat higher when nationwide emissions are considered.

An important consideration which would reduce the importance of this category is that the emissions consist of mostly large-size particles which may settle to the ground near the source itself and, thus, significantly reduce the pollutant-exposure to people. Similarly, larger particles (>2 microns) are less hazardous than finer particles since the larger particles are deposited primarily in the nasopharyngeal region of the human respiratory tract (49).

(3) Point-source evaporation. - The source-category related to solvent emission from surface coating (number 745) involves application of paint, varnish, lacquer, or paint primer for decorative and protective purposes. Many different types of industries are involved including automobile assemblies, manufacture of containers, furniture appliances, plastic products, etc.

All the emissions from this subgroup of sources are hydrocarbons only. The methods for control of hydrocarbons include adsorption using activated charcoal or use of after-burners. None of the sources had any control equipment listed in the emission data. Similarly, none of the sources had stacks. An emission factor rating of B implies the data on emissions are fairly accurate. This category may have ranked somewhat lower nationwide since the ratio of nationwide versus Chicago AQCR emissions is only 0.6.

A detailed study assessing industrial sources involving surface coating operations has been performed (50). It should be referred to for additional information on prioritization of similarly categorized different sources. Status of control equipment is also discussed in detail in the same study (50).

(4 through 7) Area source-categories. - The last four subgroups on Table XIV are area sources. In the NEDS emission data, the smallest element considered for an area source is a county. All of the eleven area source-categories are present in each of eleven counties in the

Chicago AQCR. As described in the previous chapter, no stack heights were given in the emissions data. Therefore, certain stack heights, ranging from 3 to 25 feet, were assumed for all the area sources. Most of the area source categories, with the notable exception of automobiles, have little in the way of control equipment for emissions.

Subgroup 4, comprising industrial and residential combustion sources, contribute almost 25 percent to the total popex. Again, there is virtually no control equipment used in these categories.

Transportation (subgroup 6), especially automobiles, also contribute heavily to the total popex. A substantial control program initiated by the EPA is underway to reduce CO, HC, and NO_x emissions from automobile exhaust. It may seem surprising that less-recognized air pollution sources such as heavy diesel gasoline vehicles and rail transport are also included in this rank-group. The explanation could lie in the large emissions of hydrocarbons and nitrogen oxides coupled with low "stack" height.

Solvent evaporation contributes significantly (over 1/20 of the total) to the total popex even though the emissions consist of only hydrocarbon emissions which have higher tolerance factors as compared to other pollutants (Table VI). The marketing and transportation of petroleum products, especially gasoline retailing, comprises the largest fraction of emissions in this category. Control equipment in the form of vapor recovery systems are used at various points in the gasoline distribution system except at the last stage of distribution or at the filling stations. The control efficiency ranges from 90-95 percent. The emission data for solvent evaporation have a rating of A, implying that the data are most precise. The ratio of U.S. to Chicago AQCR emissions is 0.3, which indicates that the Chicago AQCR data exaggerates the importance of this category.

Source-Categories of Popex-Rank-Group Two:

Table XVI lists source-categories having rank two. There are 53 categories in this rank-group. Popex levels of each are indicated. The categories are diverse and include all major categories of sources.

TABLE XVI. SOURCE-CATEGORIES IN POPEX - RANK - GROUP TWO

Subgroup	Source-category number	Popex Source-category	Popex Sub-total	Popex Total
EXTERNAL COMBUSTION (POINT)				5.89
Electric generation	8	0.46	1.43	
	36	0.43		
	42	0.39		
	45	0.15		
Industrial	65	0.61	4.32	
	68	0.43		
	70	0.16		
	72	0.16		
	73	0.34		
	79	0.20		
	96	0.71		
	97	0.34		
	105	0.78		
	108	0.59		
Commercial-institutional	130	0.14	0.14	
INDUSTRIAL PROCESS				6.23
Food-agricultural	349	0.23	0.23	
Primary metals	399	0.33	2.26	
	400	0.20		
	405	0.31		
	427	0.83		
	434	0.27		
	436	0.32		
Secondary metals	477	0.11	0.43	
	485	0.32		
Mineral products	528	0.47	0.80	
	612	0.12		
	632	0.21		
Petroleum industry	633	0.26	2.33	
	634	0.14		
	637	0.54		
	657	0.43		
	658	0.96		
Not classified	737	0.18	0.18	

TABLE XVI. CONTINUED

		Popex		
Subgroup	Source-category number	Source-category	Sub-total	Total
POINT-SOURCE EVAPORATION				1.09
Surface coating	743	0.33	0.46	
	746	0.13		
Petroleum	749	0.37	0.63	
	751	0.26		
SOLID WASTE DISPOSAL (POINT)				0.85
Government	761	0.52	0.52	
Commercial-institutional	782	0.11	0.11	
Industrial	796	0.22	0.22	
EXTERNAL COMBUSTION (AREA)				2.69
Residential	825	0.56	2.41	
Industrial	829	0.61		
	830	0.39		
	831	0.85		
Commercial-institutional	838	0.28	0.28	
SOLID WASTE DISPOSAL (AREA)				1.00
Residential	840	0.60	0.90	
	841	0.30		
Commercial-institutional	843	0.10	0.10	
TRANSPORTATION				2.02
Gasoline off-highway	848	0.17	0.17	
Diesel	850	0.26	0.26	
Air	854	0.65	0.65	
Vessels	858	0.11	0.11	
Gasoline handling	859	0.83	0.83	

CHAPTER IX

SENSITIVITY ANALYSIS OF THE POPEX MODEL

In the case of mathematical models with multiple input parameters, it is often useful and illuminating to determine the extent of changes in results derived from changes in the input values of different parameters. This process of analyzing the relative importance of parameters is known as sensitivity analysis. Sensitivity analysis indicates whether the results of the model are sensitive to changes or uncertainties in an input parameter. If changes in certain parameters affect the overall results more than similar changes in other parameters, it would be necessary to examine more carefully the input data and mathematical expressions related to those particular parameters. On the other hand, insensitive variables may require less detailed input data. Finally, sensitivity analysis could be used to establish an order of priorities as to which parameters or parts of the model need further refinement.

In this chapter, the method for conducting sensitivity analysis is described first, followed by results of the analysis. The integrative discussion of the approach utilized in the construction of popex and the results of sensitivity analysis are given later in this chapter.

METHOD

To estimate the sensitivity of a parameter, the extent of change in results from the base were calculated. In this sensitivity analysis the base-case input parameters were the same as those used to arrive at the results described in the preceding chapter. Popex was applied to a case where the input value of the parameters was increased by 50 percent above its base value (with all the remaining parameters kept unchanged from the base-case values). The popex levels for each of the source-categories for this modified case were calculated and compared with base-case results. The absolute values of the changes in popex for all categories were summed and the sensitivities of each of the parameters were calculated as follows:

$$\begin{array}{l}\text{Sensitivity of}\\ \text{a parameter A}\end{array} = \sum_{\substack{NA = 1\\ \text{number of}\\ \text{source-}\\ \text{categories}}}^{857} \left| (\text{popex})_{\substack{NA,\\ \text{base-case}}} - (\text{popex})_{\substack{NA,\ \text{with}\\ \text{50 percent}\\ \text{increase in}\\ \text{parameter A}}} \right|$$

A similar procedure was followed for a case with a 50 percent reduction in the input value of the same parameter. The whole process was repeated for each of the input parameters.

The theoretically maximum possible sensitivity for a parameter from the above equation is 200 (Appendix E). However, as pointed out in Appendix F, this would occur only in an extreme and unrealistic case where all the non-zero popex levels for the different source-categories would change to zero popex levels and popex for the rest of the categories would change from zero to non-zero values.

In order to further understand implications of the sensitivity in the form of percent change (above equation), the results of the sensitivity analysis were also obtained in terms of changes in rankings. Table XII shows the basis on which ranks one through five were assigned to different source categories. Changes in the rankings for each source-category from the base-case were computed. For example, the source-category "industrial-processes-lime manufacturing" (number 595) had a rank of one (popex level of 1.3 percent) in the base-case but when the tolerance factor for particulates was increased by 50 percent, it had a rank of two (popex level of 0.9 percent). This was considered as a change in ranking of one and the absolute values of such changes were summed for all the categories.

RESULTS

Table XVII lists results of the sensitivity analysis in the order of decreasing sensitivity. Both the total percent change in results as well as the change in rankings are listed. The results in the two forms are quite similar, if not the same, and thus, only the results in the form of total percent changes are referred to in the following discussion.

Decreasing the stack-heights of the area sources seemed to affect results the most. However, sensitivity to decrease in height should be viewed with caution since it represents the results from 33 area source-categories extrapolated to all 227 categories. In any case, the height of the stack is an important parameter for determining impact, since concentrations of primary pollutants decrease at ground level as the height of stack is increased (20).

TABLE XVII. RESULTS OF THE SENSITIVITY ANALYSIS

Parameter	Change in parameter by 50 percent	Total change in Topex, percent	Changes in ranking
(1) Height of the stack	Decrease	32.9[1]	27
(2) PM tolerance factor	Decrease	32.7	24
(3) SO_2 tolerance factor	Decrease	25.2	30
(4) HC tolerance factor	Decrease	23.7	22
(5) NO_x tolerance factor	Decrease	17.8	19
(6) Ring radius	Increase	14.3	9
(7) PM tolerance factor	Increase	13.9	20
(8) SO_2 tolerance factor	Increase	12.5	6
(9) HC tolerance factor	Increase	10.6	11
(10) Ring radius	Decrease	10.6	9
(11) NO_x tolerance factor	Increase	7.8	8
(12) σ_y	Decrease	6.9	5
(13) CO tolerance factor	Decrease	3.1	2
(14) Height of the stack	Increase	3.0	2
(15) θ	Increase	2.6	1
(16) θ	Decrease	2.1	4
(17) σ_y	Increase	1.5	3
(18) CO tolerance factor	Increase	1.0	2
(19) σ_z	Decrease	0.6	0
(20) σ_z	Increase	0.1	0
(21) Windspeed	Increase	0	0
(22) Windspeed	Decrease	0	0

---

[1] Extrapolated from 4.8 for 33 area source-categories

The next four parameters, in decreasing order of sensitivity (Table XVII), are related to the tolerance factors. Decreasing the tolerance factor of a pollutant means increasing the importance (or toxicity) of that pollutant as compared to others. Thus, for a same pollutant, results are more sensitive to a reduction than to an increase in tolerance factors. Results are sensitive to the tolerance factors of all the pollutants except CO. The tolerance factor for CO is very large as compared to all the others (Table VI). Thus, an increase or decrease of 50 percent does not alter appreciably the relative unimportance of CO when compared to the other pollutants.

Sensitivity of pollutant emissions was not checked, since mathematically, increasing emissions of a pollutant is the same as decreasing the tolerance factor of that pollutant. Thus, from the sensitivity of the tolerance factors, it can be inferred that the results of the model are sensitive to the emissions data.

Changing the ring radii also has significant effects on the results. Ring radius, RR, is really a lumped parameter for population and dispersion of pollutants. The meteorological parameters do not seem to have appreciable influence on the results. It was to be expected that emissions and plume height would be more important parameters than meteorological parameters related to dispersion of pollutants (51).

The changes in windspeed do not at all alter results. This is due to the fact that the same windspeed is used for all the sources. Similarly, the concentration of a pollutant and windspeed have a simple inverse relationship.

DISCUSSION

To develop a methodology based on damages associated with individual sources of air pollution for priority ranking of the sources, it was necessary to consider a substantial part of the air quality management system shown earlier (Figure 1). Specifically, factors that needed to be considered were (a) how do the pollutants disperse in the atmosphere, (b) how and to what extent are the pollutants transformed in the atmosphere, (c) where are the people located with respect to sources and what are the levels of concentrations of pollutants to which people are exposed, and lastly, (d) what are the effects of this exposure on people. Due to the complexities and numerous uncertainties associated with each of these factors, it would have been extremely difficult to construct a model which would rigorously simulate this emissions-to-effects process. The research for this dissertation did not attempt to remove the uncertainties. In this project, these uncertainties were examined and analyzed. In light of the uncertainties, simple assumptions were made to circumvent the complexities of the air pollution emission-to-effect process.

The most notable of the assumptions was that of a symmetric wind rose. As described earlier (Table IV), the average annual resultant windspeed for Chicago was from south-southwest at approximately 2 miles per hour. This implies that the wind roses at the locations where data for Chicago are monitored (Midway and O'Hare Airports) are not completely symmetrical. However, there were more important considerations which prompted the assumption of symmetric wind rose (Chapter IV).

It was shown that the wind rose at different locations in a large region could be substantially different. Annual wind data for other locations is not available routinely. Lack of such spatial meteorological data combined with the effect of Lake Michigan on recirculation of pollutants and inadequate knowledge of distribution of people around sources justifies the symmetric wind rose assumption.

The sensitivity analysis points out that even though the lumped parameter for population exposure i.e. the ring radius was important, in general, parameters related to meteorology were not significantly important in the possible alteration of the results. The sensitivity analysis also revealed that tolerance factors related to health effects were, as a group, by far the most important for changes in the results. In other words, the rankings could significantly change if the tolerance factors are changed. On the other hand, an improvement in dispersion modeling may change the results only to a limited extent.

Generally, the inability to quantitatively relate the effects of air pollutants in the management of air quality is well recognized (52). This weakness is inescapably reflected in this research. The use of tolerance factors seemed justified in this first-generation pollution-people-effect model. However, tolerance factors are only indirectly based on health-effects and they cannot be substituted for health-effect dose-response curves. In this project, considerable time was spent in analyzing the health-effects literature to examine the feasibility of construction of dose-response relationships which are based on effects of air pollution on the respiratory function. The relevant literature was reviewed and analyzed (Appendix A).

There are some excellent studies which have related specific air pollution "dosages" to effects. These include the experimental studies which, as a group, have been able to show specific dose-response relationships (Figures A-1, A-3 to A-5 in Appendix A). The results of the epidemiological group studies are less-conclusive and, hence, are not useful in the construction of longer term dose-response curves.

Appendix A assesses the air-pollution-pulmonary-effect studies based on criteria for characterization of air pollutants and characterization of pulmonary function. It was concluded that the reason for the lack of data was not due to the lack of enough studies as commonly viewed but rather due to the following study-design shortcomings: (a) an incomplete characterization of the concentration of air pollutants whose effects were being studied and inadequate recognition of other pollutants which were not being specifically studied but, nevertheless, may have been present; (b) failure to use sufficiently sensitive tests for characterization of lung function; and (c) inadequate elimination of, or accounting for, other factors which may interfer with the air pollution-effect results of a study. Details of this review and assessment are given in Appendix A.

CHAPTER X

IMPLICATIONS OF THE METHODOLOGY

In this chapter various factors that were implicit in the methodology are examined, analyzed, and highlighted. Based on a comparison and analysis of the models, a simplified procedure for the ranking of sources is presented. Next, limitations of the popex model and the methodology are enumerated. Finally, recommendations for future research are included.

APPROACH

In Chapter VIII, the results of the popex model were presented with those of mass index and pindex (Table XI). In order to understand some of the factors related to the methodology which are implicit in these models it is necessary to recapitulate how the three models: mass index, pindex and popex, differ from each other. Figure 23 shows the variables included in these models. Mass index considers only the mass emissions of five pollutants; pindex, in addition, considers tolerance factors of the pollutants. Popex includes considerations of dispersion and population in addition to pollution emissions and tolerance factors. Thus, a comparison of the results of mass index and pindex for a given source-category would indicate the influence of the tolerance factors. Similarly, a comparison of the results of pindex versus popex would show the effect of factors related to dispersion and population.

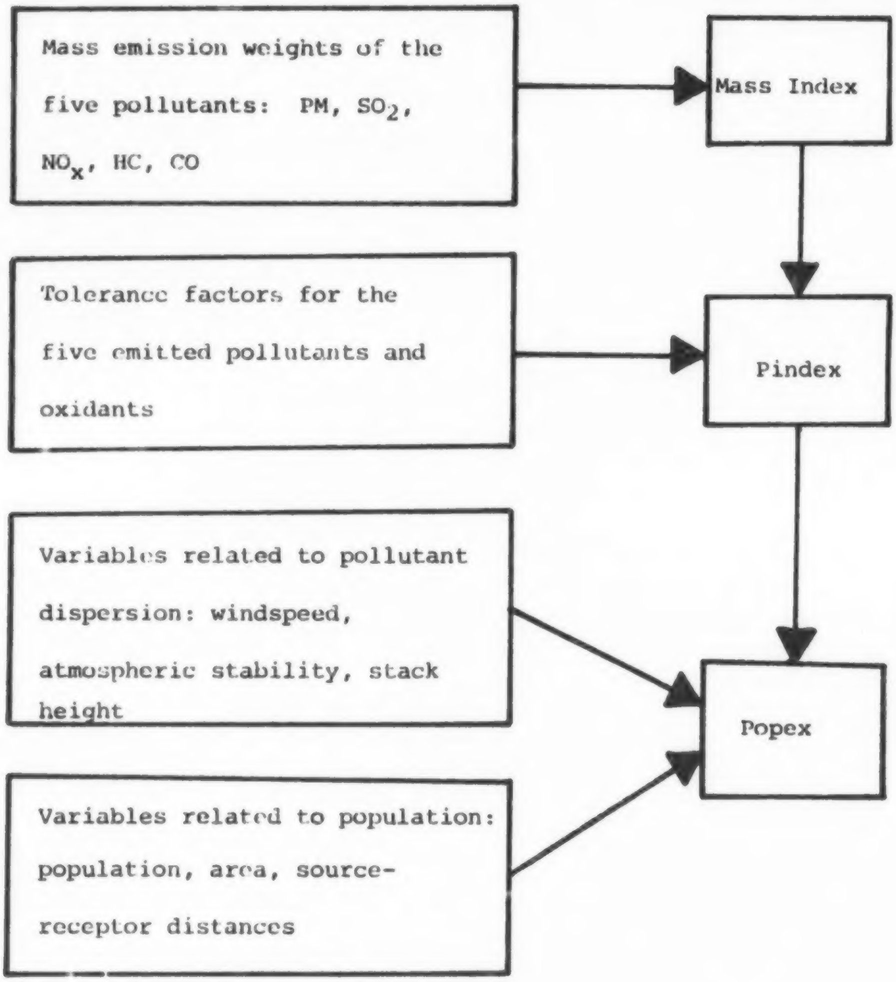
Mass emission weights of the five pollutants: PM, SO_2, NO_x, HC, CO
Mass Index
Tolerance factors for the five emitted pollutants and oxidants
Pindex
Variables related to pollutant dispersion: windspeed, atmospheric stability, stack height
Popex
Variables related to population: population, area, source-receptor distances

Figure 23. Indices and Variables

Finally, an analysis of the factors which differentiate the models would allow one to examine implications which are not seen otherwise.

For this analysis, two ratios are calculated for each of the source-categories as follows:

$$\left(\frac{\text{PI}}{\text{MI}}\right)_{\text{NA}} = \frac{\text{pindex for source-category NA, percent}}{\text{mass index for source-category NA, percent}}$$

$$\left(\frac{\text{PO}}{\text{PI}}\right)_{\text{NA}} = \frac{\text{popex for source-category NA, percent}}{\text{pindex for source-category NA, percent}}$$

Thus, for example, for the source-category 8 from Table X:

$$\left(\frac{\text{PI}}{\text{MI}}\right)_{8} = \frac{1.16}{0.48} = 2.42$$

$$\left(\frac{\text{PO}}{\text{PI}}\right)_{8} = \frac{0.46}{1.16} = 0.40$$

Table XVIII gives these ratios for all of the source-categories.

PI/MI

The mass index, pindex, and PI/MI are listed in the first three columns of Table XVIII. The ratio PI/MI depends on the tolerance factors and mix of the pollutant emissions of a source category. CO has the largest tolerance factor, whereas SO_2 has the smallest (Table VI). Consequently, PI/MI is the largest or equal to 2.58 for the source-categories which have only SO_2 emissions. The categories with only SO_2 emissions include boilers burning special fuel (category number 118, a single source), manufacture of sulfuric acid (category 268) and natural gas flares (category 651). On the other hand, PI/MI is the smallest

TABLE XVIII. INDICES,PI/MI,PO/PI AND SOURCE LOCATIONS FOR SOURCE CATEGORIES IN CHICAGO AQCR.

SOURCE CATEGORY	MASS INDEX	PINDEX	$\frac{PI}{MI}$	POPEX	$\frac{PO}{PI}$	NUMBER OF SOURCES IN COUNTIES[1] 1	2	3	4	5	6	7	8	9	10	11	TOTAL
8	0.482	1.162	2.41	0.461	0.40	2	0	0	0	0	0	4	0	0	0	0	6
9	5.037	12.507	2.48	4.450	0.36	3	0	0	0	0	0	3	0	6	15	0	27
10	2.728	6.651	2.44	3.590	0.54	7	0	0	0	0	0	2	0	5	0	2	16
11	0.011	0.023	2.20	0.025	1.09	5	0	0	0	0	0	0	0	0	0	0	5
36	0.446	1.024	2.30	0.428	0.42	5	10	0	0	0	0	4	0	2	4	5	30
37	0.002	0.004	2.38	0.001	0.17	0	0	0	0	0	0	0	0	1	0	0	1
39	0.001	0.001	1.67	0.0	0.08	0	0	0	0	0	0	0	0	0	0	5	5
42	0.346	0.670	1.94	0.387	0.58	16	10	0	0	0	0	0	0	6	1	7	40
43	0.001	0.001	1.86	0.0	0.17	0	0	0	0	0	0	0	0	1	0	0	1
45	0.550	1.206	2.19	0.147	0.12	0	0	0	0	0	0	0	0	0	3	5	8
65	0.239	0.533	2.23	0.610	1.14	3	0	0	0	0	0	0	0	0	0	0	3
66	1.922	4.480	2.33	2.295	0.51	3	0	1	0	0	0	0	0	1	12	0	17
68	0.341	0.811	2.38	0.427	0.53	1	1	0	0	0	0	0	0	5	3	0	10
70	0.049	0.109	2.21	0.159	1.46	6	0	0	0	0	0	0	0	0	0	0	6
72	0.316	0.717	2.27	0.161	0.23	0	0	0	0	0	0	1	0	3	3	0	7
73	0.423	0.954	2.26	0.344	0.36	3	6	0	0	5	0	9	0	2	4	0	29
77	0.001	0.002	1.98	0.0	0.19	0	0	0	1	0	0	0	0	0	0	0	1
79	0.054	0.120	2.22	0.203	1.69	3	0	0	0	0	0	0	0	0	0	0	3

[1] 1-COOK,2-DUPAGE,3-GRUNDY,4-KANE,5-KANKAKEE,6-KENDALL,7-LAKE,8-MCHENRY,9-WILL,10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	$\frac{PI}{MI}$	POPEX	$\frac{PO}{PI}$	NUMBER OF SOURCES IN COUNTIES[1] 1	2	3	4	5	6	7	8	9	10	11	TOTAL
96	0.942	2.298	2.44	0.714	0.31	9	0	0	0	0	0	1	0	2	36	0	48
97	0.279	0.676	2.42	0.333	0.49	29	2	0	3	1	0	6	1	25	6	0	73
98	0.031	0.073	2.37	0.089	1.22	13	0	0	0	0	0	0	0	0	4	0	17
99	0.023	0.055	2.40	0.014	0.26	0	0	0	0	0	0	0	0	0	5	0	5
100	0.001	0.002	2.37	0.001	0.33	0	0	0	0	0	0	0	0	0	1	0	1
101	0.004	0.008	2.27	0.004	0.53	3	0	0	0	0	0	0	0	0	3	0	6
102	0.036	0.068	1.86	0.030	0.44	7	1	2	2	0	0	0	0	4	13	0	29
103	0.083	0.155	1.86	0.080	0.52	31	4	0	6	7	0	13	2	36	4	0	103
104	0.034	0.061	1.77	0.062	1.02	17	0	0	9	1	0	0	0	3	4	0	34
105	1.005	2.238	2.23	0.782	0.35	1	0	0	0	0	0	0	0	0	47	4	52
106	0.063	0.155	2.46	0.041	0.26	0	0	0	0	0	0	0	0	0	16	0	16
108	0.400	0.990	2.47	0.592	0.60	0	0	0	0	0	0	0	0	0	4	0	4
110	0.0	0.001	1.82	0.0	0.43	0	0	0	1	0	0	0	0	0	1	0	2
111	0.0	0.001	1.86	0.0	0.33	0	0	0	0	0	0	0	0	0	1	0	1
112	0.002	0.005	2.41	0.002	0.29	0	0	0	0	0	0	0	0	0	1	0	1
118	0.013	0.033	2.58	0.008	0.25	0	0	0	0	0	0	0	0	0	1	0	1
128	0.011	0.026	2.34	0.004	0.14	0	0	0	0	0	0	0	0	1	0	0	1
130	0.237	0.528	2.23	0.139	0.26	3	0	0	7	10	0	0	0	0	0	0	20

[1] 1-COOK,2-DUPAGE,3-GRUNDY,4-KANE,5-KANKAKEE,6-KENDALL,7-LAKE,8-MCHENRY,9-WILL,10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	PI/MI	POPEX	PO/PI	1	2	3	4	5	6	7	8	9	10	11	TOTAL
						NUMBER OF SOURCES IN COUNTIES[1]											
135	0.001	0.001	1.43	0.002	2.77	1	0	0	0	0	0	0	0	0	0	0	1
136	0.011	0.024	2.25	0.004	0.15	0	0	0	0	0	0	0	0	2	0	0	2
147	0.006	0.014	2.32	0.040	2.77	2	0	0	0	0	0	0	0	0	0	0	2
148	0.001	0.003	2.18	0.008	2.77	4	0	0	0	0	0	0	0	0	0	0	4
149	0.001	0.003	1.85	0.005	1.95	8	1	0	1	0	0	2	0	0	0	0	12
151	0.004	0.009	2.19	0.025	2.72	5	0	0	0	0	0	1	0	0	0	0	6
152	0.021	0.049	2.30	0.013	0.27	3	1	0	0	0	0	7	0	3	0	0	14
153	0.001	0.001	1.85	0.001	0.48	0	0	0	0	0	0	1	0	0	0	0	1
154	0.002	0.004	1.72	0.008	2.23	4	0	0	2	0	0	0	0	0	0	0	6
179	0.003	0.006	2.00	0.012	1.93	1	0	0	0	0	0	0	0	0	0	0	1
181	0.012	0.012	1.02	0.024	2.01	1	0	0	0	0	0	0	0	0	0	0	1
183	0.025	0.001	0.04	0.002	1.98	3	0	0	0	0	0	0	0	0	0	0	3
205	0.026	0.051	1.96	0.097	1.92	5	0	0	0	0	0	0	0	0	1	0	6
208	0.111	0.221	2.00	0.039	0.18	0	0	0	0	0	0	0	0	1	0	0	1
209	0.001	0.001	2.00	0.0	0.17	0	0	0	0	0	0	0	0	1	0	0	1
210	0.012	0.032	2.58	0.006	0.18	0	0	0	0	0	0	0	0	1	0	0	1
211	0.038	0.080	2.11	0.014	0.17	0	0	0	0	0	0	0	0	1	0	0	1
221	0.036	0.072	2.00	0.012	0.17	0	0	0	0	0	0	0	0	1	0	0	1

[1] 1-COOK, 2-DUPAGE, 3-GRUNDY, 4-KANE, 5-KANKAKEE, 6-KENDALL, 7-LAKE, 8-MCHENRY, 9-WILL, 10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	$\frac{PI}{MI}$	POPEX	$\frac{PC}{PI}$	NUMBER OF SOURCES IN COUNTIES[1] 1	2	3	4	5	6	7	8	9	10	11	TOTAL
230	0.005	0.005	1.07	0.011	2.09	2	0	0	0	0	0	0	0	0	0	0	2
234	0.002	0.002	1.02	0.004	1.96	1	0	0	0	0	0	0	0	0	0	0	1
237	0.001	0.001	1.02	0.0	0.28	0	0	0	0	0	0	1	0	0	0	0	1
244	0.006	0.013	1.96	0.025	2.00	1	0	0	0	0	0	0	0	0	0	0	1
247	0.003	0.007	1.96	0.012	1.79	1	0	0	0	0	0	0	0	0	0	0	1
249	0.004	0.004	1.02	0.009	2.04	1	0	0	0	0	0	0	0	0	0	0	1
262	0.013	0.034	2.53	0.005	0.16	0	0	0	0	0	0	0	0	1	0	0	1
263	0.039	0.099	2.55	0.018	0.18	0	0	0	0	0	0	0	0	2	0	0	2
267	0.079	0.204	2.58	0.049	0.24	0	0	0	0	0	0	0	0	0	1	0	1
268	0.092	0.239	2.58	0.049	0.21	0	0	0	0	0	0	0	0	0	2	0	2
301	0.003	0.005	1.96	0.009	1.76	1	0	0	0	0	0	0	0	0	0	0	1
305	0.016	0.031	1.96	0.050	1.63	1	0	0	0	0	0	0	0	0	0	0	1
306	0.006	0.012	1.96	0.025	2.00	1	0	0	0	0	0	0	0	0	0	0	1
333	0.024	0.029	1.17	0.043	1.52	3	0	0	0	0	0	1	0	0	5	0	9
345	0.0	0.001	1.96	0.0	0.59	1	0	0	0	1	0	0	0	0	0	0	2
346	0.001	0.002	1.96	0.003	1.98	2	0	0	0	0	0	0	0	0	0	0	2
347	0.0	0.001	1.96	0.002	1.90	1	0	0	0	0	0	0	0	0	0	0	1
349	0.058	0.114	1.96	0.228	2.00	1	0	0	0	0	0	0	0	0	0	0	1

[1] 1-COOK, 2-DUPAGE, 3-GRUNDY, 4-KANE, 5-KANKAKEE, 6-KENDALL, 7-LAKE, 8-MCHENRY, 9-WILL, 10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	$\frac{PI}{MI}$	POPEX	$\frac{PO}{PI}$	NUMBER OF SOURCES IN COUNTIES[1] 1	2	3	4	5	6	7	8	9	10	11	TOTAL
350	0.018	0.034	1.96	0.069	2.00	1	0	0	0	0	0	0	0	0	0	0	1
351	0.010	0.020	1.96	0.040	2.00	1	0	0	0	0	0	0	0	0	0	0	1
352	0.006	0.013	1.96	0.022	1.76	1	0	0	0	0	0	0	0	0	0	0	1
354	0.001	0.002	1.96	0.001	0.33	0	0	0	0	0	0	0	0	0	1	0	1
361	0.015	0.030	1.96	0.010	0.35	0	0	0	0	0	0	0	0	0	7	0	7
379	0.001	0.001	1.96	0.002	1.90	1	0	0	0	0	0	0	0	0	0	0	1
389	0.003	0.007	1.96	0.013	1.90	1	0	0	0	0	0	0	0	0	0	0	1
399	0.890	1.113	1.25	0.327	0.29	0	0	0	0	0	0	0	0	0	21	2	23
400	0.400	0.499	1.24	0.202	0.40	1	0	0	0	0	0	0	0	0	21	2	24
401	0.098	0.156	1.59	0.067	0.43	1	0	0	0	0	0	0	0	0	21	2	24
402	0.090	0.172	1.91	0.088	0.51	1	0	0	0	0	0	0	0	0	21	2	24
405	0.273	0.704	2.58	0.312	0.44	0	0	0	0	0	0	0	0	0	21	0	21
425	0.016	0.008	0.50	0.012	1.50	1	0	0	0	0	0	0	0	0	0	0	1
426	0.012	0.023	1.96	0.012	0.51	0	0	0	0	0	0	0	0	0	20	2	22
427	3.608	1.220	0.34	0.833	0.68	2	0	0	0	0	0	0	0	0	14	0	16
429	0.034	0.058	1.70	0.029	0.50	1	0	0	0	0	0	0	0	0	11	1	13
433	0.007	0.015	2.29	0.005	0.35	1	0	0	0	0	0	0	0	0	6	0	9
434	0.356	0.727	2.04	0.270	0.37	0	0	0	0	0	0	0	0	0	47	0	47

[1] 1-COOK,2-DUPAGE,3-GRUNDY,4-KANE,5-KANKAKEE,6-KENDALL,7-LAKE,8-MCHENRY,9-WILL,10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	PI/MI	POPEX	PO/PT	1	2	3	4	5	6	7	8	9	10	11	TOTAL
						NUMBER OF SOURCES IN COUNTIES[1]											
435	0.227	0.112	0.49	0.064	0.58	1	0	0	0	0	0	0	0	0	5	3	9
436	1.326	0.900	0.68	0.324	0.36	4	0	0	0	0	0	0	0	0	1	0	5
437	0.002	0.003	1.96	0.005	1.34	2	0	0	0	0	0	0	0	0	0	0	2
438	0.002	0.005	2.06	0.010	1.98	2	0	0	0	0	0	0	0	0	0	0	2
440	0.0	0.0	1.96	0.0	0.28	0	0	0	0	0	0	0	0	0	1	0	1
463	0.008	0.016	1.96	0.025	1.54	1	0	0	1	0	0	0	0	0	0	0	2
471	0.005	0.009	1.96	0.017	1.83	3	0	0	0	0	0	0	0	0	0	0	3
472	0.001	0.002	1.96	0.003	1.50	1	0	0	0	0	0	0	0	0	0	0	1
473	0.0	0.0	1.96	0.0	0.19	0	0	0	0	0	0	0	0	1	0	0	1
474	0.012	0.024	1.96	0.042	1.75	2	0	0	0	0	0	0	0	0	0	0	2
475	0.004	0.007	1.96	0.013	1.79	2	0	0	0	0	0	0	0	0	0	0	2
476	0.001	0.003	1.96	0.005	1.88	1	0	0	0	0	0	0	0	0	0	0	1
477	0.493	0.048	0.10	0.107	2.24	4	0	0	2	1	0	0	0	1	1	0	9
478	0.0	0.0	1.96	0.0	1.73	2	0	0	0	0	0	0	0	0	0	0	2
479	0.0	0.0	1.96	0.001	1.46	1	0	0	1	0	0	1	0	0	0	0	3
485	0.067	0.168	2.50	0.321	1.91	1	0	0	0	0	0	0	0	0	0	0	1
494	0.001	0.003	1.97	0.004	1.35	2	0	0	0	0	0	0	0	0	1	0	3
495	0.045	0.089	1.96	0.074	0.84	2	0	0	0	0	0	0	0	0	2	0	4

[1] 1-COOK, 2-DUPAGE, 3-GRUNDY, 4-KANE, 5-KANKAKEE, 6-KENDALL, 7-LAKE, 8-MCHENRY, 9-WILL, 10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	$\frac{PI}{MI}$	POPEX	$\frac{PO}{PI}$	NUMBER OF SOURCES IN COUNTIES[1]											
						1	2	3	4	5	6	7	8	9	10	11	TOTAL
498	0.0	0.0	1.96	0.0	0.35	0	0	0	0	0	0	0	0	0	1	0	1
499	0.003	0.003	1.03	0.005	2.00	1	0	0	0	0	0	0	0	0	0	0	1
500	0.001	0.001	1.96	0.002	1.83	1	0	0	0	0	0	0	0	0	0	0	1
502	0.0	0.0	1.96	0.0	1.91	1	0	0	0	0	0	0	0	0	0	0	1
504	0.0	0.0	1.96	0.001	2.00	1	0	0	0	0	0	0	0	0	0	0	1
520	0.003	0.006	1.96	0.012	1.93	1	0	0	0	0	0	0	0	0	0	0	1
522	0.015	0.017	1.10	0.006	0.34	1	0	0	0	0	0	0	0	1	2	0	4
523	0.002	0.005	1.96	0.001	0.21	0	0	0	0	0	0	1	0	1	0	0	2
524	0.0	0.0	1.96	0.001	2.31	1	0	0	0	0	0	0	0	0	0	0	1
525	0.001	0.001	0.97	0.001	0.91	1	0	0	0	0	0	0	0	0	1	0	2
527	0.016	0.031	1.97	0.040	1.29	6	0	0	0	0	0	2	0	0	0	0	8
528	0.135	0.265	1.96	0.469	1.77	6	0	0	0	0	0	1	0	0	0	0	7
530	0.016	0.031	1.96	0.063	2.07	1	0	0	0	0	0	0	0	0	0	0	1
531	0.024	0.048	1.96	0.081	1.69	1	0	0	0	0	0	0	0	0	0	0	1
533	0.0	0.001	1.69	0.0	0.35	0	0	0	0	0	0	0	0	0	2	0	2
541	0.002	0.004	1.96	0.002	0.40	0	0	0	0	0	0	0	0	0	2	0	2
544	0.0	0.0	1.96	0.0	0.34	0	0	0	0	0	0	0	0	0	1	0	1
546	0.001	0.002	1.96	0.001	0.41	0	0	0	0	0	0	0	0	0	3	0	3

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[1] 1-COOK,2-DUPAGE,3-GRUNDY,4-KANE,5-KANKAKEE,6-KENDALL,7-LAKE,8-MCHENRY,9-WILL,10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	$\frac{PI}{MI}$	POPEX	$\frac{PO}{PI}$	NUMBER OF SOURCES IN COUNTIES[1] 1	2	3	4	5	6	7	8	9	10	11	TOTAL
547	0.022	0.043	1.96	0.082	1.91	1	0	0	0	0	0	0	0	0	1	0	2
548	0.008	0.017	1.96	0.032	1.93	1	0	0	0	0	0	0	0	0	0	0	1
551	0.146	0.343	2.35	0.100	0.29	0	0	0	0	0	0	0	0	0	1	0	1
559	0.013	0.026	1.96	0.001	0.06	0	0	2	0	0	0	0	0	0	0	0	2
560	0.047	0.093	1.96	0.005	0.06	0	0	2	0	0	0	0	0	0	0	0	2
579	0.001	0.001	1.02	0.0	0.10	0	0	0	0	0	0	0	0	0	0	1	1
582	0.004	0.008	1.96	0.008	1.08	1	0	0	0	0	0	2	0	0	0	0	3
589	0.002	0.005	1.96	0.001	0.28	0	0	0	0	0	0	1	0	0	1	0	2
590	0.0	0.0	1.96	0.0	0.29	0	0	0	0	0	0	0	0	0	1	0	1
591	0.0	0.001	1.96	0.0	0.29	0	0	0	0	0	0	0	0	0	1	0	1
592	0.093	0.182	1.96	0.032	0.18	1	0	1	0	0	0	0	0	0	0	0	2
593	0.011	0.022	1.96	0.001	0.05	0	0	2	0	0	0	0	0	0	0	0	2
595	0.406	0.797	1.96	1.283	1.61	6	0	0	0	0	0	0	0	0	0	0	6
605	0.001	0.001	1.96	0.0	0.27	0	0	0	0	0	0	1	0	0	0	0	1
610	0.024	0.047	1.96	0.009	0.19	0	0	0	1	0	0	0	0	5	0	0	6
611	0.055	0.107	1.96	0.021	0.19	0	0	0	1	0	0	0	0	5	0	0	6
612	0.287	0.563	1.96	0.118	0.21	1	0	0	0	0	0	0	0	4	0	0	5
614	0.014	0.028	1.96	0.005	0.18	0	0	0	0	0	0	0	0	1	0	0	1

[1] 1-COOK,2-DUPAGE,3-GRUNDY,4-KANE,5-KANKAKEE,6-KENDALL,7-LAKE,8-MCHENRY,9-WILL,10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	PI/MI	POPEX	PO/PI	NUMBER OF SOURCES IN COUNTIES[1] 1	2	3	4	5	6	7	8	9	10	11	TOTAL
615	0.064	0.126	1.96	0.052	0.41	2	0	0	1	0	0	0	0	3	0	0	6
616	0.272	0.533	1.96	0.097	0.18	0	0	0	1	0	0	0	0	5	0	0	6
617	0.726	1.424	1.96	2.289	1.61	4	0	0	0	0	0	0	0	0	0	0	4
632	0.052	0.101	1.96	0.210	2.07	1	0	0	0	0	0	0	0	0	0	0	1
633	0.396	0.995	2.51	0.262	0.26	0	0	0	0	0	0	0	0	0	8	0	8
634	0.150	0.367	2.45	0.141	0.38	1	0	0	0	0	0	0	0	0	8	0	9
637	5.673	0.729	0.13	0.540	0.74	2	0	0	0	0	0	0	0	1	2	0	5
638	0.080	0.163	2.04	0.040	0.24	0	0	0	0	0	0	0	0	0	2	0	2
639	0.001	0.001	1.02	0.0	0.22	0	0	0	0	0	0	0	0	1	0	0	1
642	0.051	0.052	1.02	0.012	0.23	0	0	0	0	0	0	0	0	1	0	0	1
645	0.047	0.048	1.02	0.009	0.19	0	0	0	0	0	0	0	0	1	0	0	1
646	0.006	0.006	1.02	0.001	0.23	0	0	0	0	0	0	0	0	1	0	0	1
647	0.002	0.002	1.02	0.0	0.19	0	0	0	0	0	0	0	0	1	0	0	1
648	0.004	0.004	1.02	0.001	0.23	0	0	0	0	0	0	0	0	1	0	0	1
649	0.001	0.001	1.02	0.0	0.20	0	0	0	0	0	0	0	0	1	0	0	1
650	0.002	0.002	1.02	0.001	0.39	0	0	0	0	0	0	0	0	0	1	0	1
651	0.0	0.0	2.58	0.001	1.18	1	0	0	0	0	0	0	0	0	0	0	1
657	3.223	1.673	0.52	0.432	0.26	0	0	0	0	0	0	0	0	0	10	0	10

[1] 1-COOK,2-DUPAGE,3-GRUNDY,4-KANE,5-KANKAKEE,6-KENDALL,7-LAKE,8-MCHENRY,9-WILL,10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	PI/MI	POPEX	PO/PI	NUMBER OF SOURCES IN COUNTIES[1] 1	2	3	4	5	6	7	8	9	10	11	TOTAL
658	0.518	1.271	2.45	0.964	0.76	4	0	0	0	0	0	0	0	0	7	0	11
677	0.0	0.0	1.96	0.0	1.96	1	0	0	0	0	0	0	0	0	0	0	1
692	0.010	0.020	1.96	0.041	2.00	1	0	0	0	0	0	0	0	0	0	0	1
693	0.003	0.006	1.96	0.011	1.83	1	0	0	0	0	0	0	0	0	0	0	1
706	0.0	0.001	2.58	0.0	0.60	0	0	0	0	0	0	0	0	0	1	0	1
714	0.004	0.009	2.58	0.003	0.31	1	0	0	0	0	0	0	0	0	8	0	9
730	0.0	0.0	2.36	0.001	1.88	1	0	0	0	0	0	0	0	0	0	0	1
731	0.004	0.007	1.96	0.011	1.50	1	0	0	0	0	0	0	0	0	0	0	1
737	0.120	0.222	1.85	0.176	0.80	2	0	0	0	0	0	0	0	0	5	2	9
739	0.007	0.007	1.02	0.002	0.22	0	0	0	1	0	0	0	0	0	0	0	1
741	0.011	0.011	1.02	0.001	0.09	0	0	0	0	1	0	0	0	0	0	0	1
743	0.217	0.222	1.02	0.325	1.46	23	2	0	12	1	0	2	3	2	0	0	45
744	0.009	0.009	1.02	0.018	2.00	2	0	0	0	0	0	0	0	0	1	0	3
745	0.601	0.612	1.02	1.142	1.87	5	0	0	1	0	0	0	0	0	0	0	6
746	0.072	0.073	1.02	0.133	1.82	1	0	0	2	0	0	0	0	0	1	0	4
747	0.050	0.050	1.02	0.085	1.68	2	0	0	0	0	0	0	0	0	1	0	3
748	0.005	0.005	1.02	0.0	0.06	0	0	1	0	0	0	0	0	0	0	0	1
749	0.920	0.937	1.02	0.373	0.40	4	0	0	0	0	0	1	0	101	1	0	107

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[1] 1-COOK,2-DUPAGE,3-GRUNDY,4-KANE,5-KANKAKEE,6-KENDALL,7-LAKE,8-MCHENRY,9-WILL,10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	$\frac{PI}{MI}$	POPEX	$\frac{PO}{PI}$	NUMBER OF SOURCES IN COUNTIES[1] 1	2	3	4	5	6	7	8	9	10	11	TOTAL
750	0.030	0.031	1.02	0.005	0.16	0	0	0	0	0	0	0	0	9	0	0	9
751	0.672	0.685	1.02	0.262	0.38	2	0	0	0	0	0	0	0	96	1	0	99
752	0.035	0.036	1.02	0.006	0.16	0	0	0	0	0	0	0	0	8	0	0	8
758	0.014	0.014	1.02	0.030	2.17	1	0	0	0	0	0	0	0	0	0	0	1
760	0.007	0.008	1.02	0.014	1.88	1	0	0	0	0	0	0	0	0	0	0	1
761	0.412	0.388	0.94	0.521	1.35	9	0	0	0	0	0	0	0	0	0	0	9
762	0.065	0.060	0.93	0.089	1.49	4	0	0	0	0	0	0	0	1	0	0	5
778	0.001	0.001	1.03	0.002	1.59	1	0	0	0	0	0	0	0	0	1	0	2
782	0.070	0.042	0.59	0.107	2.58	3	0	0	0	0	0	0	0	0	0	0	3
783	0.0	0.001	1.21	0.002	2.77	1	0	0	0	0	0	0	0	0	0	0	1
795	0.005	0.005	1.13	0.003	0.53	1	0	0	0	1	0	0	0	0	0	0	2
796	0.194	0.206	1.06	0.224	1.09	5	0	0	1	0	0	0	0	2	0	0	8
797	0.0	0.001	2.06	0.0	0.15	0	0	0	0	0	0	0	0	1	0	0	1
802	0.0	0.0	1.17	0.0	0.60	0	0	0	0	0	0	0	0	0	1	0	1
821	0.002	0.001	0.69	0.001	0.38	0	0	0	0	0	0	0	0	0	1	1	2
822	2.156	3.091	1.43	5.489	1.78	1	1	1	1	1	1	1	1	1	1	1	11
823	0.772	1.722	2.23	2.784	1.62	1	1	1	1	1	1	1	1	1	1	1	11
825	0.237	0.359	1.51	0.558	1.55	1	1	1	1	1	1	1	1	1	1	1	11

[1] 1-COOK, 2-DUPAGE, 3-GRUNDY, 4-KANE, 5-KANKAKEE, 6-KENDALL, 7-LAKE, 8-MCHENRY, 9-WILL, 10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	$\frac{PI}{MT}$	POPEX	$\frac{PO}{PT}$	NUMBER OF SOURCES IN COUNTIES[1] 1	2	3	4	5	6	7	8	9	10	11	TOTAL
826	0.001	0.001	1.82	0.001	1.05	1	0	0	0	0	0	1	0	1	1	0	4
828	3.604	8.053	2.23	12.478	1.55	1	1	1	1	1	1	1	1	1	1	1	11
829	0.155	0.367	2.36	0.606	1.65	1	1	1	1	1	0	1	1	1	1	1	10
830	0.113	0.250	2.22	0.394	1.58	1	1	1	1	1	0	1	1	1	1	1	10
831	0.328	0.561	1.71	0.848	1.51	1	1	1	1	1	1	1	1	1	1	1	11
835	0.081	0.185	2.28	0.067	0.36	0	0	0	0	0	0	0	0	0	1	1	2
836	0.740	1.745	2.36	2.813	1.61	1	1	1	1	1	1	1	1	1	1	1	11
837	0.035	0.077	2.22	0.028	0.36	0	0	0	0	0	0	0	0	0	1	1	2
838	0.109	0.183	1.68	0.282	1.54	1	1	1	1	1	1	1	1	1	1	1	11
840	1.346	0.546	0.40	0.597	1.10	1	1	1	1	1	1	1	1	1	1	1	11
841	0.340	0.201	0.59	0.305	1.52	1	1	1	1	1	1	1	1	1	1	1	11
842	0.047	0.044	0.93	0.048	1.10	1	1	1	1	1	1	1	1	1	1	1	11
843	0.113	0.067	0.59	0.102	1.52	1	1	1	1	1	1	1	1	1	1	1	11
844	1.260	1.172	0.93	1.896	1.62	1	1	1	1	1	1	1	1	1	1	1	11
845	1.965	1.158	0.59	1.875	1.62	1	1	1	1	1	1	1	1	1	1	1	11
846	33.642	11.648	0.35	22.891	1.97	1	1	1	1	1	1	1	1	1	1	1	11
847	4.631	1.887	0.41	2.687	1.42	1	1	1	1	1	1	1	1	1	1	1	11
848	1.126	0.326	0.29	0.174	0.53	1	1	1	1	1	1	1	1	1	1	1	11

[1] 1-COOK,2-DUPAGE,3-GRUNDY,4-KANE,5-KANKAKEE,6-KENDALL,7-LAKE,8-MCHENRY,9-WILL,10-LAKE IN, 11-PORTER

TABLE XVIII. CONTINUED.

SOURCE CATEGORY	MASS INDEX	PINDEX	$\frac{PI}{MI}$	POPEX	$\frac{PD}{PI}$	NUMBER OF SOURCES IN COUNTIES[1] 1	2	3	4	5	6	7	8	9	10	11	TOTAL
849	1.212	1.604	1.32	2.755	1.72	1	1	1	1	1	1	1	1	1	1	1	11
850	0.152	0.200	1.31	0.255	1.28	1	1	1	1	1	1	1	1	1	1	1	11
851	0.515	0.760	1.48	1.122	1.48	1	1	1	1	1	1	1	1	1	1	1	11
852	0.021	0.019	0.90	0.035	1.84	1	1	0	0	0	0	1	0	0	0	0	3
853	0.050	0.015	0.31	0.024	1.55	1	1	0	0	0	0	0	0	0	0	0	2
854	0.500	0.324	0.65	0.646	2.00	1	0	0	0	0	0	0	0	0	0	0	1
856	0.017	0.025	1.48	0.013	0.50	1	1	1	0	0	0	1	0	1	1	1	7
857	0.031	0.071	2.29	0.027	0.39	1	0	1	0	0	0	0	0	1	1	1	5
858	0.332	0.093	0.28	0.106	1.14	1	0	1	0	1	0	1	1	1	1	1	8
859	0.501	0.510	1.02	0.825	1.62	1	1	1	1	1	1	1	1	1	1	1	11
861	2.887	2.940	1.02	5.477	1.86	1	1	1	1	1	1	1	1	1	1	1	11
					TOTAL	419	64	37	80	53	21	95	30	398	531	74	1802

[1] 1-COOK,2-DUPAGE,3-GRUNDY,4-KANE,5-KANKAKEE,6-KENDALL,7-LAKE,8-MCHENRY,9-WILL,10-LAKE IN, 11-PORTER

(0.04) for sources which have only CO emissions, such as in manufacture of ammonia by the catalytic reformer process from natural gas (category 183). All other source-categories have the PI/MI between these two extremes. For example: (a) sources such as boilers for electric power generation as well as many industrial boilers with emissions of SO_2 and particulates have generally a high PI/MI (1.96 to 2.58); (b) food and grain processing industries which have only particulate emissions have PI/MI of 1.96; (c) for the various solvent-evaporation sources, PI/MI is in the vicinity of 1; and (d) at the lower end of PI/MI scale (0.04 to 0.4) are sources such as automobiles with large CO and HC emissions.

PO/PI

The comparison of PO/PI for the different source categories is more complicated than the comparison of PI/MI. In addition to the emissions and tolerance factors considered in pindex, popex includes considerations of atmospheric dispersion and population exposure. Popex and PO/PI are shown in column 4 and 5 of Table XVIII. For each of the source-categories, columns 7 through 17 of Table XVIII indicate county locations and number of sources. Generally, PO/PI is large if the majority of sources of a source-category are located in a populated county, such as Cook County. PO/PI also depends on the height of emission stacks.

In order to evaluate the impact of population, area, and the stack height on PO/PI, source-categories which had all the sources located in a single county were chosen for further analysis. PO/PI of such categories is influenced by the population area of a single county instead of a complex combination of population and areas of many counties. For example, out of the first four categories listed on Table XVIII, only source-category 11 has all of the five sources located in a single county (Cook). Thus, source-category 11 was selected and PO/PI of this category, along with the stack heights of the sources included in this category, were noted. In the case of a source-category which had sources with different stack heights, a pindex-weighted average stack height was computed for the emissions and stack height data given in Appendix D and the tolerance factors given in Table VI.

Six counties (Cook, Grundy, Kane, Lake in Illinois, Lake in Indiana, and Will) out of the eleven counties had source-emission data satisfying the criterion of having all sources of a source-category located in a single county. PO/PI for these six counties are plotted versus the stack height (Figure 24). Plots for each of the six counties are straight lines. The slopes increase with increasing population densities (Table XIX).

To visualize the influence of the variables related to population, area, and stack heights, PO/PI is plotted against the county population densities (Figure 25). According to Figure 25, for a constant stack height the impact of a source as measured by PO/PI increases with increasing population density. Similarly for the same population density, PO/PI on the population-health-effect impact of a source increases with decreasing stack height.

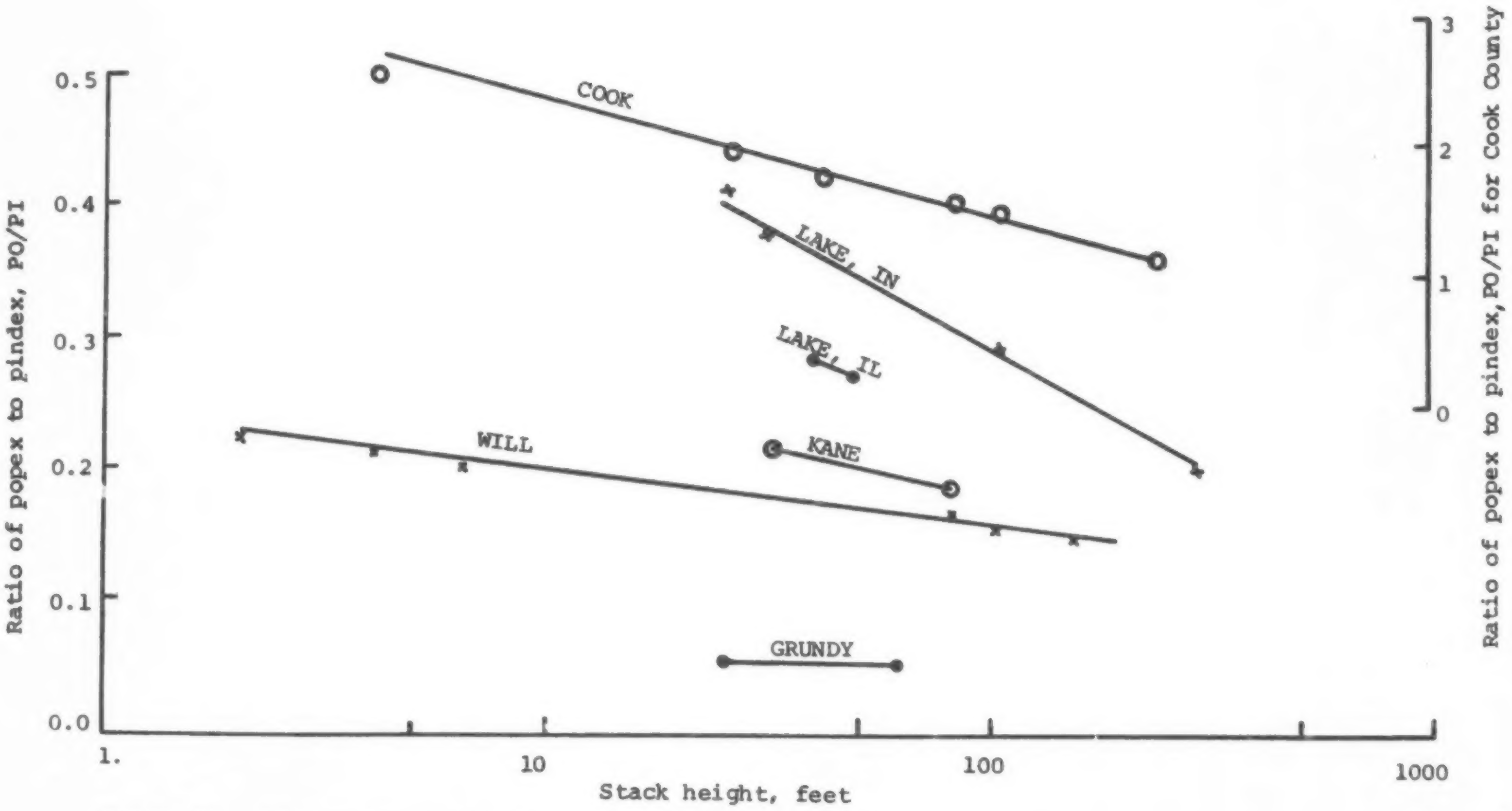

Figure 24. Plots of stack heights versus PO/PI for different counties.

TABLE XIX. POPULATION DENSITIES AND SLOPES OF PO/PI VERSUS STACK HEIGHTS FOR SIX COUNTIES

County	Population density people/square mile	Slope $\frac{PO/PI}{\text{Stack height, in meter}^{-1}}$
Grundy	61	.0001
Will	295	.0006
Kane	483	.0009
Lake, Illinois	837	.0016
Lake, Indiana	1,065	.0021
Cook	5,753	.0096

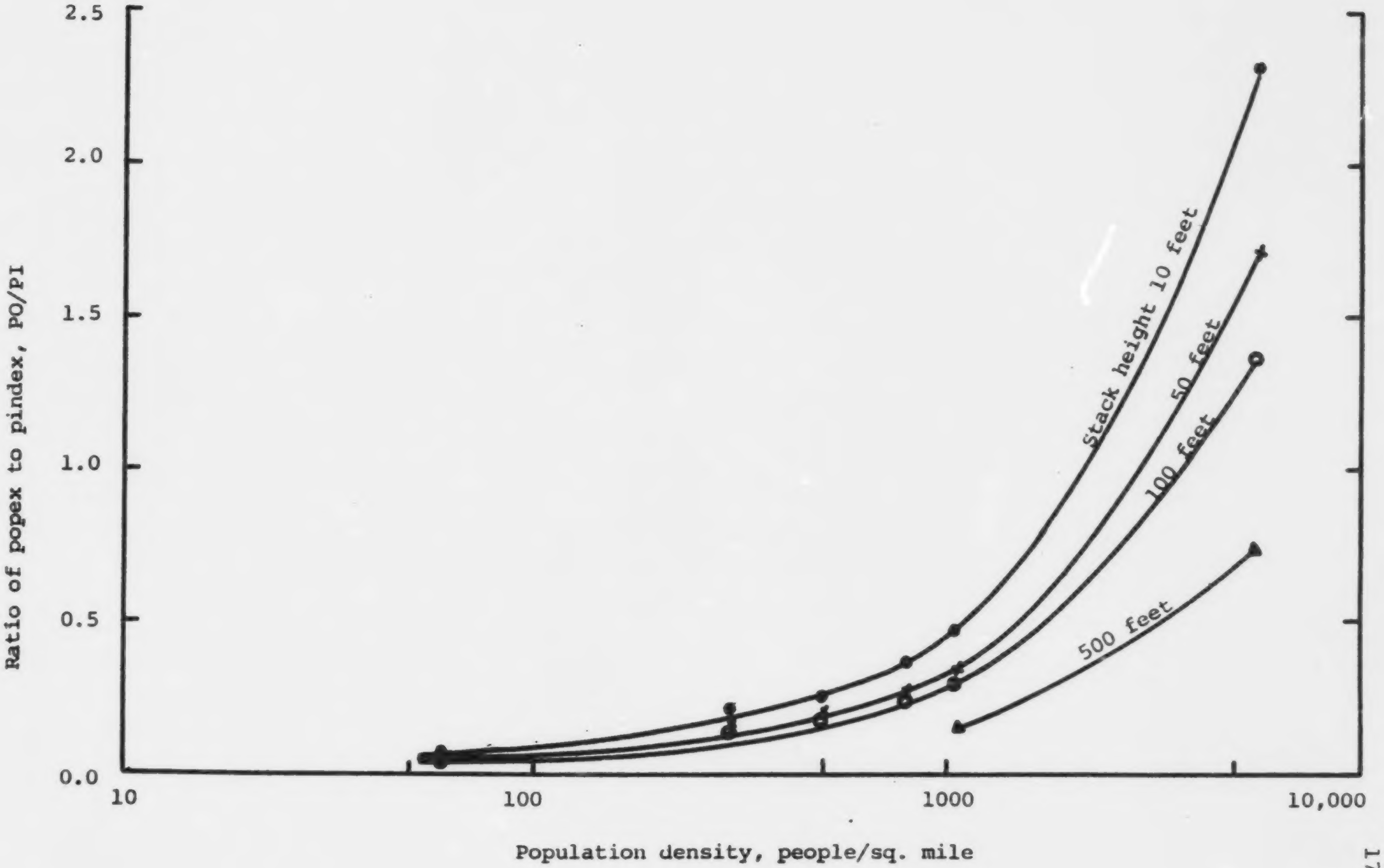

Figure 25. Relationships of PO/PI versus population density for different stack heights.

IMPLICATIONS

Both of the above observations related to stack height and population density variables are generally accepted. However, Figure 25 which is based on results of the computer models, pindex and popex, provides a quantitative method for comparison of the health-effect impact on people attributable to the sources of air pollution.

Pindex is a useful way to combine emissions of different pollutants into a single number and it is used in the following section for evaluating the impact of sources. The comparison of PI/MI for different sources indicates the relative health-impact of their emissions.

PO/PI and its relation to population densities is useful for estimation of the relative impact on the population of two or more sources of air pollution. In calculating the ratio, the effect of mass emissions and pollutant-tolerance factors are eliminated and thus PO/PI becomes a measure of the extent of population exposure only. By combining the pindex calculations with the relation of PO/PI with stack height and population density, one can estimate the relative dispersion, population and health-effect impact of different sources without using the computer simulation.

A Simple Method for Determining Relative Impact of Emission Sources

The preceding analysis can be used to determine the relative impact of sources. As in popex, the data required are the emissions of the five pollutants, stack heights, and population densities of the counties in which the sources are located.

The method for determination of impact involves three steps:

(1) Apply tolerance factors (Table VI) to the emission data. Pindex for each source N can be calculated using the following expression:

$$(\text{pindex})_N = \sum_{K=1}^{5} \text{emissions}(N,K) \times TF(K)$$

where emissions(N,K) are the emissions in tons per year of pollutant K from source N. TF(K) is the factor based on the tolerance factor FF(K) and TF(K) = FF(CO)/FF(K).

(2) From Figure 25, obtain the ratio PO/PI for the appropriate stack height and population density.

(3) Calculate popex for each source from

$$(\text{popex})_N = \left(\frac{PO}{PI}\right)_N \times (\text{pindex})_N$$

This method can efficiently be used for a smaller number of sources (less than ten). For a large number of sources, the direct use of the popex computer model would be preferred.

LIMITATIONS OF THE POPEX MODEL

An important limitation on the use of the popex model is that it should be used in toto or, in other words, parts of the model should not be used independently of the rest of the model. To balance the complexity and inadequacies in data, popex was built as a "package". Thus, it may be unfruitful to use the population submodel of popex with other dispersion models such as AQDM. Similarly, the dispersion submodel should not be used only for estimation of air quality.

Secondary pollutants other than ozone were not considered in the model. Inclusion of a mechanism of formation of secondary pollutants like sulfate or nitrates, etc., and their tolerance factors could possibly alter the results.

Other limitations are explicit in the methodology of the construction of the submodels. For example, since the model is based on average annual factors, episodic conditions are not considered in the model.

Finally, the research for this dissertation is a "first-generation" attempt to combine diverse parts of the air quality management system. Thus, this work does not provide unchangeable or ever-correct answers. As our understanding of many of the lesser known factors related to air pollution and its effects grows, the popex model could be improved. Further verifications and improvements in the model are left to others and to the future. Recommendations for future work are given in the following section.

FUTURE WORK

Future work related to this research could be performed in many directions. Some of the specific recommendations are:

(1) Results of the popex model could be compared with rankings arrived at by a totally different method, for example, a ranking based on economic and/or technological considerations. Similarly, the results of other prioritization studies mentioned in Chapter I (3,4) could be compared with the results of the popex model. A comprehensive comparison of rankings by different approaches would help in establishing true priorities.

(2) Popex model was applied to Chicago AQCR data. Even though the

emission inventory of the Chicago AQCR was largely representative of national emissions, it would be useful to apply popex to some other region for comparison of the rankings.

(3) Specific parts of the model could be improved. Of course, health-effect modeling deserves a high priority. The dose-response curves for short term (a few hours) responses to ozone and sulfur dioxide are presented in Figures A-1 and A-3 to A-5 of Appendix A. The levels of pollutant concentrations included in these figures are somewhat higher than generally experienced for O_3 and, in the case of SO_2, concentrations are substantially higher than ambient levels. When more definitive dose-response information is available for the short term effect as well as for longer term effects (several months or years) of all the pollutants with concentrations near the ambient levels, it could be used instead of the tolerance factors for a more-realistic priority rankings of sources.

(4) The computer program of popex is flexible and could be modified to consider the impact of secondary pollutants such as sulfates and nitrates when more definitive information on mechanism of formation and on dose-response relationships is available.

(5) Population distributions which are specific to various air pollution sources could be explored and added to the popex methodology.

(6) Dispersion model could be refined and expanded to include other meteorological conditions not presently included.

CHAPTER XI

CONCLUSIONS

The results of the popex model show that seventeen out of a total of 227 source-categories are responsible for nearly 80 percent of the air-pollution-population effect problem (Tables XI and XIII). These seventeen categories include commonly recognized large sources, such as automobiles, large utility and industrial boilers, mineral product industries, etc., as well as less-recognized categories such as solvent evaporations from operations involving surface coatings. These source-categories have been individually discussed, and the factors which could possibly change the rankings are enumerated in Chapter VIII.

The Industrial Environmental Research Laboratory of the EPA has ongoing research, development, and demonstration projects for control of emissions from all the stationary source-categories assigned rank one by popex, except possibly for the control of solvent emissions in industrial operations (48). Methods for control of solvent or hydrocarbon emissions include adsorption using activated charcoal or use of afterburners, but these do not appear to be in widespread use. It may be necessary to develop better and more economical methods for control of hydrocarbons in operations involving solvents. Perhaps, a more important problem related to hydrocarbon emissions is the lack of a hydrocarbon emission inventory which classifies the emissions according to their reactivities. A more realistic mechanisms for the formation of oxidant than the one included in this project may not be of significant use until such a hydrocarbon emission inventory is available.

The sensitivity analysis of the popex model provides interesting results. Tolerance factors which are related to health effects of air pollutants were identified as the parameters most sensitive in the popex model. Other parameters including the variables related to meteorological dispersion were shown to be of less importance. The results of the sensitivity analysis thus indicate that any additional effort for improvement or additions in the model should be aimed at improving the part related to health effects.

The present tolerance factors are only indirectly based on health effects. Construction of dose-response relationships is essential to the development of a more realistic model. However, sufficient data are not available for developing these relationships. The review and analysis of studies on the effect of air pollution on human pulmonary function (Appendix A) shows that the lack of usable health-effects data is not due to lack of studies in this area, as commonly believed, but is primarily due to the failure in a majority of these studies to adequately characterize the cause (air pollutants), and the effect (pulmonary function) as well as inadequate recognition and elimination of interference factors. These and other aspects of the health-effects studies are discussed and suggestions for future studies are included in Appendix A.

Until more definitive information on dose-response relationships is available, use of the tolerance factors, described in this dissertation, appears to be the best available means for assessing the relative impact of the exposure to any combination of the six pollutants.

The third significant output of this project is to supply a simple method for assessing relative impact of air pollution in a situation with a smaller number of sources. Development of the proposed method was based on the analysis of the results of the popex model (Chapter X), and this method does not require the use of a computer.

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APPENDIX A

ASSESSMENT OF EXISTING STUDIES OF HEALTH EFFECTS OF AIR POLLUTION

SUMMARY

Studies on the health effects of air pollutants were reviewed and evaluated. In order to provide a quantitative frame of reference, only the studies which have used pulmonary function tests for characterization of the health effects were selected for this assessment.

The past studies reported in the literature were divided into four groups based on study designs. Results of the studies in each of the groups were collectively analyzed. Whenever possible, based on the data reported in these studies, dose-response curves were constructed. Some of the more subtle results of the studies are also discussed.

The studies in each of the four groups were examined in detail for the relative merits of their methodologies. In the determination of the relative merit of the methodologies, the degree of resolution and the quality of results were considered to be of significant importance. This analysis showed why some of the studies, or groups of studies, have yielded useful results, whereas others have not. The reasons for this situation are discussed and recommendations for future work are included.

Based on this review and the assessment of the past studies it is concluded that the tolerance factors are still the best available means

for a relative assessment of the damage potential of the six pollutants

INTRODUCTION

In this dissertation, the tolerance factors derived from the air quality standards were used for quantification of relative effects of the six air pollutants: particulate matter, PM; sulfur dioxide, SO_2; nitrogen oxides, NO_x; carbon monoxide, CO; hydrocarbons, HC; and oxidants, Ox. The derivation and the use of the tolerance factors are given in Chapter VI. The air quality standards are based on deleterious effects on humans, vegetation, property, etc. of the air pollutants and thus the tolerance factors are based on health effects. The tolerance factors, however, allow only a single-point comparison of the relative effects of pollutants. Dose-response relationships are necessary for a more realistic assessment of the effects of each pollutant as well as for a comparison of effects among the different pollutants. In this appendix, results of the studies on the health effects of air pollutants were reviewed and analyzed in depth for possible construction of dose-response relationships. Furthermore, these studies were examined for the relative merits of their methodologies.

Dose-response Relationships

Dose-response relationships or predictive equations for health effects of air pollutants, allow one to estimate effects of various levels of dosages of air pollutants. The parameter related to dosages of air pollutants could be a complex combination of time and concentration variables. For example, the effect of continuous exposure to constant level of air pollutants may be different than intermittant exposure to similar concentrations especially if the degree of effect depends on cumulative exposures.

Similarly, "response" parameters on dose-response curves could also be a combination of effects. Generally the response is characterized (a) by increase in incidence of diseases, (b) by aggravation of existing diseases, or (c) some clinical indicators, such as pulmonary function tests or level of carboxyhemoglobin in blood.

Pulmonary Function Tests

Review of the literature on health effects of the six air pollutants (PM, SO_2, NO_x, CO, HC, Ox) showed that in numerous studies various pulmonary function tests have been used alone or in conjunction with other approaches for characterization of effects. This is not surprising since inhalation is the major route of entry of pollutants into the human body and most of these pollutants, with the exception of CO and HC, have their primary effects on the respiratory system. The pulmonary function tests supply objective and quantitative information. Similarly, pulmonary function measurements could indicate effects at a subclinical level which can not be adequately reflected if only increases in incidence of diseases are considered. Symptomology should be considered for a complete characterization of effects on the respiratory system. Studies involving pulmonary function tests were selected for this research in order to evaluate the effects of air pollutants in a generalized and quantitative manner.

TABLE A-I. LUNG VOLUMES, CAPACITIES AND PULMONARY FUNCTION MEASUREMENTS:

NOMENCLATURE AND DEFINITIONS (A1).

Name	Abbreviation	Explanation/definition
Lung volumes and capacities		
Tidal volume	TV	The volume of gas inspired or expired during each respiratory cycle (liters)
Residual volume	RV	The volume of gas remaining in the lungs at the end of a maximal expiration (liters)
Total lung capacity	TLC	The amount of gas contained in the lung at the end of a maximal inspiration (liters)
Vital capacity	VC	The maximal volume of gas that can be expelled from the lungs (liters)
Functional residual capacity	FRC	The volume of gas remaining in the lungs at the resting expiratory level (liters)
Pulmonary function measurements		
Forced vital capacity	FVC	Maximum volume measured on forced expiration after the deepest inspiration (liters)
Forced expiratory volume	FEV_t	Volume of gas expired over a given time interval, t, (in seconds) during a forced expiration (liters)

TABLE A-I. CONTINUED

Pulmonary function measurements		
Forced expiratory time	FET	Time required to expel the total vital capacity during a maximal forced expiration (in seconds)
Peak expiratory flow	PEF	Peak expiratory flow rate (liters per second)
Mid-maximum expiratory flow	MMEF	Flow rate during 25-75% segment of VC of the forced expiratory volume (liters per second)
Maximum expiratory flow	$\mathrm{MEF}_{\%vc}$	Instantaneous maximum expiratory flow rate at specified lung volumes
Maximum expiratory flow volume curves	MEFV curves	Graphic recording of flow versus volume during a forced expiratory volume maneuver followed by forced inspiration (flow in liters/second and volume in liters)
Airway resistance	Raw	Airway resistance is measured by body plethysmograph using the relation: airway resistance = (atmospheric pressure - alveolar pressure)/flow
Specific conductance	SGaw	Reciprocal of (Raw x Vtg) where Vtg is thoracic gas volume
"Closing" volume	CV	Lung volume at which dependent lung regions tend to close. A normal person can expire fully to residual volume; persons whose lungs have less elastic recoil, whose airways have lost structural supporting tissue or whose airways are narrowed, develop widespread airway collapse and trapping when they breathe between RV and FRC or even at higher volumes.

TABLE A-1. CONTINUED.

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Pulmonary function measurements		
Static and dynamic compliance	Cst, Cdyn	Slope of static recoil pressure and the volume of lungs reflects lung compliance. When lung stiffness increases as a pathological phenomenon, compliance is low. The measurement of compliance during breathing is called as dynamic compliance (Cdyn) and the compliance measured from the static curve is called as static compliance (Cst). Cdyn is frequency dependent and can be used to assess airways obstruction in disease.

Some of the many diagnostic techniques used for the assessment of pulmonary function or pulmonary function tests (PFTs) include (a) spirometric, (b) flow-volume curve, (c) airway resistance, (d) closing volume, and (e) compliance measurements. The measurement techniques are briefly described in Table A-I[1] which also contains definitions of various lung volumes and capacities (A1).

Physiological changes as a result of exposure to air pollution are qualitatively similar to those observed in certain pulmonary diseases. In evaluation of obstructive pulmonary diseases, the criteria given in Table A-II are often used (A2).

TABLE A-II. CRITERIA FOR EVALUATION OF OBSTRUCTIVE PULMONARY DISEASES.

PFT[1]	Reduction from Normal Values, Percent	Severity of Disease
FEV_1 PEF	<20 >50	minimal
FEV_1	20-35	mild
FEV_1	35-50	moderate
FEV_1	50-65	severe
FEV_1	>65	very severe

[1] For explanation of abbreviations of the pulmonary function tests see Table A-I.

As shown later in this appendix reductions in the pulmonary function measurements due to air pollution and due to respiratory infections are smaller in magnitude (less than 10 percent at the most) than given in Table A-II.

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[1] Numbers of all the tables, figures and references in the Appendix have a prefix 'A' to distinguish them from the rest of the dissertation.

Scope

Studies on measurement of health effects of air pollution include animal and human experimental studies done in an exposure-chamber set up, and human epidemiological studies performed under environmental or occupational conditions. Each of these types of studies have their advantages and limitations. In order to have a complete and reliable characterization of the effects, all of the above-mentioned types of studies are required. In this research the studies which have used the pulmonary function tests for characterization of effects of the air pollutants on the human lung were considered. The literature reviewed in this study is not exhaustive, however an effort was made to include the majority of recent (after 1970) studies published in English-language journals.

Format of Presentation

The studies have been divided into four groups for review and analysis of their results (Table A-III). This grouping was done only for convenience in analysis of the studies and the inclusion of a study under one or another group could, in some instances, be arbitrary.

In the following section, first results of the studies in each of the groups are reviewed for construction dose-response curves. In the section entitled 'Comments', some of the results and other subtle

TABLE A-III. THE GROUPING OF HEALTH-EFFECT STUDIES.

Groups	Type of Studies
Experimental	Studies done in exposure chambers.
Epidemiological	
Group 1 - correlation	The goal of these studies was to correlate results of the pulmonary function measurements with the environmental variables.
Group 2 - cross-sectional	Studies which compare two or more groups of subjects having different air pollution exposures.
Group 3 - longitudinal	Studies assessing long-term effect of air pollution

points which are common to all of the groups are collectively discussed. Later the method and the results of assessment of the studies in the four groups are described.

EXPERIMENTAL STUDIES (A3-A11)

Experimental Details

The details of the parameters studied in each of the experimental exposure-chamber studies are given in Table A-IV. In most of the studies the duration of exposures were not more than a few hours at a time. All the studies except one (A11) used artificially generated pollutants. Ozone in seven studies was the most studied single pollutant; two

TABLE A-IV. SUMMARY OF THE EXPERIMENTAL STUDIES.

Studies Parameters	Young *et al.* (A3)	Hallet (A4)	Bates *et al.* (A5)	Hazucha *et al.* (A6)
Year of the study[1]	1963	1964	1971	1972
Duration of exposures	2 hr.	30 min.	2 hr.	2 hr.
Pollutants	ozone	ozone	ozone	ozone
Concentrations, ppm	0.6-0.8	1 - 3	0.75	0.37,0.75
Generated or ambient	gen.	gen.	gen.	gen.
Pulmonary function tests				
FVC, TLC	FVC	FVC	FVC	FVC,TLC
FRC, RV				RV
FEV_t	$FEV_{.75}$	FEV_1	FEV_1	FEV_1
PEF		PEF		PEF
MMEF	MMEF	MMEF	MMEF	MMEF
$MEF_{\%VC}$				
MEFV Curves			MEFV	MEFV
CV				CV
Raw, Vtg[4]				
Cst. Cdyn			Cst,Cdyn	
DL_{CO}	DL_{CO}	DL_{CO}		
Other				
Population	11 adults (10 males, 1 female), ages 20-45 years	20 normal adults (9 males, 11 females) ages 17-38. 5 COPD patients (2 males, 3 females ages 48-61.	10 males ages 22-35.	24 males, age 24. 12 smokers, 12 nonsmokers.

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[1] Approximate, based on year of acceptance of the particular paper for publication or on year of publication.

[2] Other pollutants such as oxidants, nitrogen oxides may have been present which were not monitored.

[3] Particulate measured as number of particles per cubic feet for different size ranges (accurate conversion to $\mu g/m^3$ very difficult). SO_2 levels were monitored and were generally two-thirds less than the ambient levels.

[4] Specific conductance or Gaw/Vtg were calculated from Raw and Vtg.

[5] Partial expiratory flow rate at 50 percent VC.

TABLE A-IV. SUMMARY OF THE EXPERIMENTAL STUDIES. (CONTINUED)

Studies Parameters	Kagawa and Toyama (A7)	Hackney *et al.* (A8)	Hackney *et al.* (A9)	Anderson *et al.* (A10)	Kerr (A11)
Year of the study[1]	1974	1974	1974	1973	1972
Duration of exposures	5 min.	4 hr.	2 hr.	6 hr.	6 days
Pollutants	ozone	ozone	ozone	SO_2	PM, SO_2[2]
Concentrations, ppm	0.9	0.25,0.37, 0.5	0.25,0.37, 0.5	1,5,25	---[3]
Generated or ambient	gen.	gen.	gen.	gen.	amb.
Pulmonary function tests					
FVC, TLC		FVC,TLC	FVC,TLC		TLC
FRC,RV	FRC	RV	RV		FRC,RV
FEV_t		FEV_1	FEV_1	FEV_1	FEV_1, FEV_3
PEF		PEF	PEF		PEF
MMEF					MMEF
$MEF_{\%VC}$		MEF_{50} MEF_{25}	MEF_{50} MEF_{25}		
MEFV Curves		MEFV	MEFV		
CV		CV	CV	CV	
Raw, Vtg[4]	Raw,Vtg	Raw,Vtg	Raw,Vtg		Raw,Vtg
Cst,Cdyn		Cst, Cdyn	Cst, Cdyn		
DL_{CO}		DL_{CO}			
Other			$MEF_{50}P$[5] $MEF_{50}P$	nasal flow resistance	
Population	4 males, ages 20-25.	4 normal males, average age 43. 4 males sensitive to air pollution, average age 34.	3 groups 5-7 normal and reactive males, age 27-41.	15 males, ages 20-28.	6 males average age 29.

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[1] Approximate, based on year of acceptance of the particular paper for publication or on year of publication.

[2] Other pollutants such as oxidants, nitrogen oxides may have been present which were not monitored.

[3] Particulate measured as number of particles per cubic feet for different size ranges (accurate conversion to μg/m^3 very difficult). SO_2 levels were monitored and were generally two-thirds less than the ambient levels.

[4] Specific conductance or Gaw/Vtg were calculated from Raw and Vtg.

[5] Partial expiratory flow rate at 50 percent VC.

involved a combination of O_3, NO_2 and CO; and one study dealt with SO_2. The study done by Kerr (A11) used "natural" or ambient air pollutants and it also had the longest duration (six days) of exposures.

Generally, an experimental set-up allows better characterization of variables and a greater degree of control over experimental variables and the factors which may affect the results. This fact is reflected on Table A-IV. The experimentation with ambient air with simultaneous control of temperature and humidity poses special problems. These problems are discussed later in this appendix.

In the last ten or twelve years there have been substantial improvements in experimental techniques and design of the exposure-chamber studies. The problems encountered in these types of studies were first discussed by Bates (A12) and Bates et al. (A13), and more recently by Hackney et al. (A14). Due to the difficulty in establishing statistically significant changes in pulmonary function before and after the exposures, recent studies have used a larger and larger number of PFTs. This fact is apparent when Hallet's pre-1964 study (A4) which used five PFTs, is compared with the recent Hackney et al. studies (A8, A9) in which 10-14 different tests were used. All the experimental studies done after 1970 generally have adequate characterization of changes in pulmonary function (Table A-IV).

Results

Ozone. - Similar experimental protocol and conditions in the studies done by two groups: Hazucha et al. (A6) and Hackney et al. (A8, A9) allow construction of a dose-response curve in terms of FEV_1. The curve shown in Figure A-1 is, in most cases, for two-hour exposures with intermittant exercise and is based on "average" FEV_1 responses for each of the two studies. Hackney et al (A8) studied two groups of subjects: one group of "normal" male subjects who had no history of cough, chest discomfort or wheezing associated with allergy or air pollution, and a "reactive" group of male subjects who had some of these symptoms. In the experiment with the normal group, there were no significant and consistant changes in normals in most of the tests even with a four-hour exposure to 0.5 ppm ozone.

However, for the "reactive" group, FEV_1 decreased significantly. The data-points shown in Figure A-1 are average of response for the normal and the reactive group (A9). Smokers and nonsmokers were studied separately in the study by Hazucha et al. (A6). Although smokers and nonsmokers had different initial pulmonary function measurements, the changes in FEV_1 due to exposure to ozone were similar in both the groups.

The dose-response curve shown in Figure A-1 was for single exposures of ozone and the "dose" was defined by concentration of ozone only. For more realistic dose-response curves or for response-predictive expressions, effects of the length of duration of exposures as well as the effect of cumulative exposures have to be considered. Although enough quantitative information for construction of such response-predictive expressions is not available, qualitative effect of the above mentioned factors as well as other factors such as exercise are discussed below.

One series of experiments done by Hackney (A8) gave an opportunity

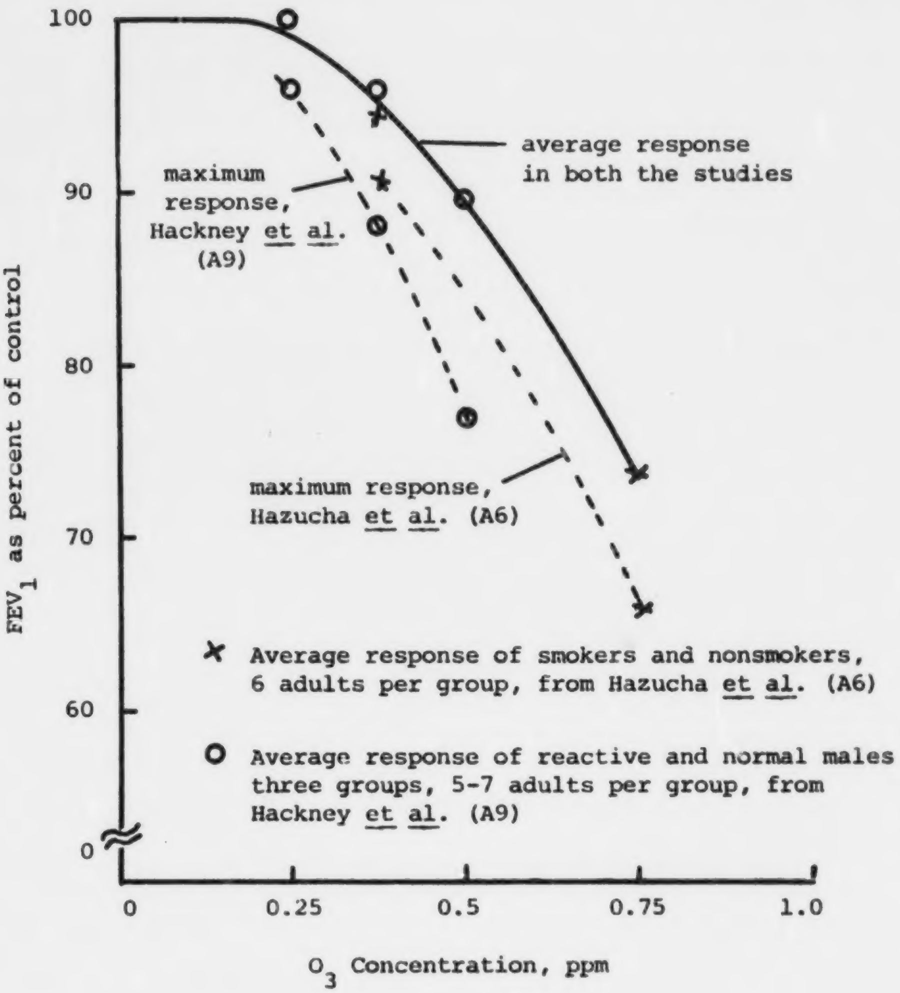
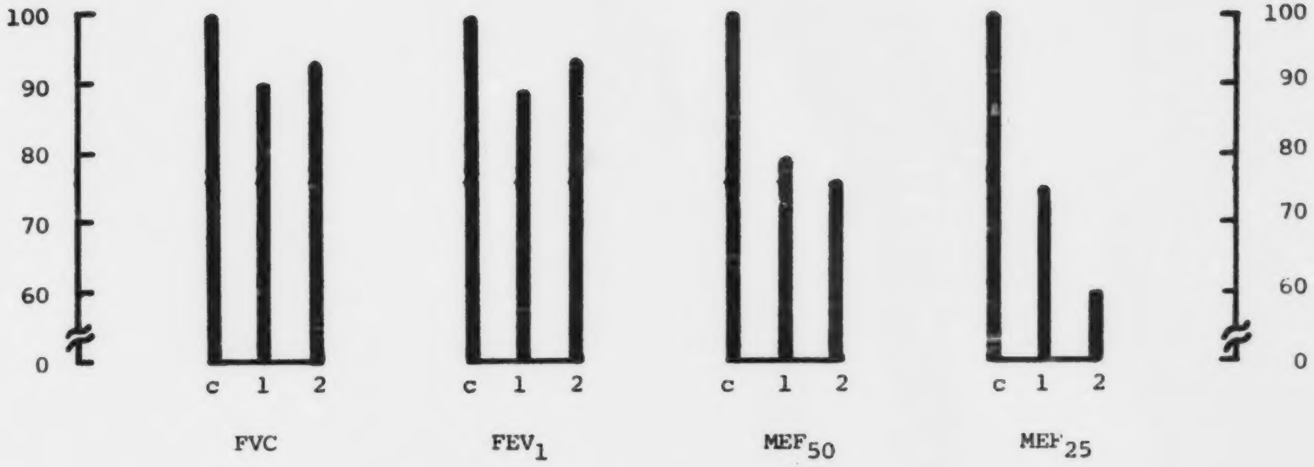


Figure A-1. Dose-response curve for two hours of exposure to ozone for adults.

to examine the effect of a combination of two factors: cumulative exposure and the duration of exposure (Figure A-2). In this particular experiment, with four-hour exposures, on the second day of exposure to 0.5 ppm ozone the experiment had to be stopped at the end of two hours for three out of four subjects. Thus the data reported for various PFTs in Figure A-3 are for four-hour exposure on the first day and two-hour exposure on the following day. In Figure A-2, the effect of cumulative exposure is seen in MEF_{50} and MEF_{25} since second-day values for these tests are lower than for the first day despite the fact that duration of exposure was reduced on the second day. In FVC and FEV_1 such cumulative effect is not seen and the results of these tests appear to be dependent on the length of exposure. These conclusions should be considered as tentative since the differences between the first and second day of exposures may not be statistically significant.

The observations in Figure A-2 were for "reactive" subjects and showed the combined effect of cumulative exposures and duration of exposures. The effect on the pulmonary function is greater when the length of exposure increases from one to two hours. Table A-V shows the changes in the statistical levels of significance between the controls and the group subjected to one-hour and two-hour exposures to 0.37 ppm ozone. The level of significance improved in all cases with an increase in duration of exposures (Table A-V). Levels of significance for 0.75 ppm ozone are even better (A6). Figure A-3 shows that MMEF decreases by approximately 20% after each one and two hours of exposures for 0.75 ppm ozone. It is likely that some type of "leveling off" in reduction



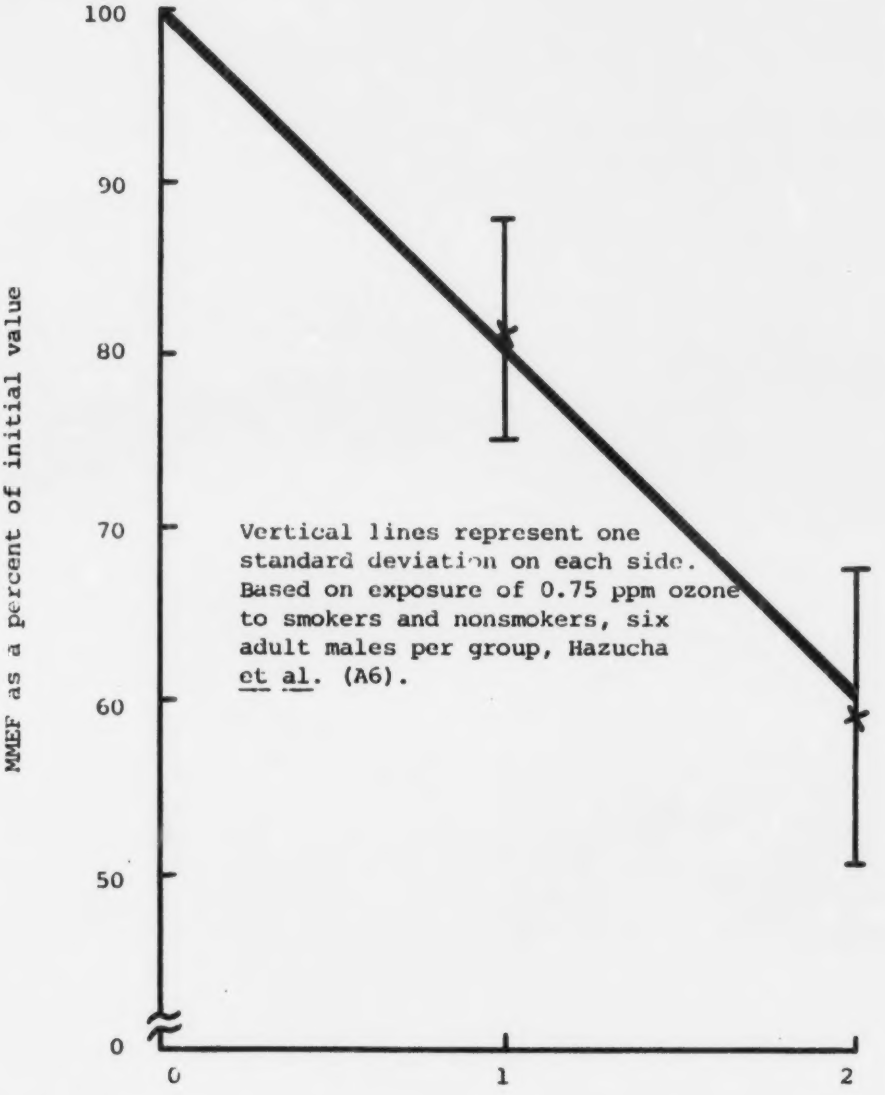
c - control
1 - exposure to 0.5 ppm ozone first day, four hours, as percent of control
2 - exposure to 0.5 ppm ozone the following day, two hours, as percent of control

Figure A-2. Effect of combination of cumulative exposures and duration of exposures on four "reactive" adult males (A8).

TABLE A-V. CHANGES IN LEVEL OF SIGNIFICANCE DUE TO A CHANGE IN DURATION OF EXPOSURES OF SMOKERS AND NONSMOKERS TO 0.37 PPM OZONE (A6)

Test	Nonsmoker/ Smoker	Level of statistical significance for the difference from the control	
		One-hour exposure of 0.37 ppm O_3	Two-hour exposure of 0.37 ppm O_3
FVC	nonsmoker	<.05	<.01
	smoker	<.05	<.001
FEV_1	nonsmoker	NS[1]	<.01
	smoker	NS	<.005
MMEF	nonsmoker	NS	<.05
	smoker	NS	<.05
MEF_{50}	nonsmoker	NS	<.01
	smoker	NS	<.05

[1] NS - not significant at 0.05



Vertical lines represent one standard deviation on each side. Based on exposure of 0.75 ppm ozone to smokers and nonsmokers, six adult males per group, Hazucha et al. (A6).

Figure A-3. Dose-response curve for ozone: effect of durations of exposures.

would occur after two hours but this certainly is not seen up to two hours of exposures. Studies of longer exposure durations are required for any further analysis of effect of the length of exposure.

The effect of cumulative exposure is also clearly seen in normal subjects. The exposure to 0.5 ppm ozone on two consecutive days showed a marked reduction in lung function on the second day (A9). On the first day of the two-day exposures (two hours each day) only one out of 13 PFTs showed a significant change from the control measurements. However, on the second day, 10 out of the same 13 tests showed significant changes.

The effects of ozone are more pronounced with exercise. The comparison of results of Young *et al*. (A3) with no exercise and Hazucha *et al*. (A6) with moderate intermittant exercise (enough to double the minute volume) show that for similar concentration there is a greater decrease in FEV_t with exercise. Similarly, Kagawa and Toyama (A7) found no significant difference in Gaw/Vtg from control if the subjects did not undertake exercise. With exercise, the difference in Gaw/Vtg was highly significant (Table A-VI). It thus appears that exercise exacerbates the effect of ozone in view of the significant difference between the effects of ozone with and without exercise observed in these respiratory function studies. However, based on available information, incorporation of effect of exercise in dose-response curves was not possible.

Ozone, nitrogen dioxide and carbon monoxide. - No consistent results were obtained in two experimental studies with sequential exposure to

TABLE A-VI. EFFECTS OF OZONE AND EXERCISE ON THE PULMONARY FUNCTION OF MALE ADULTS.

Study	Concentrations and Duration of Exposure	Excercise	PFT	Level of Significance of the difference from control (no ozone)
Young *et al.* (A3)	0.6 - 0.8 ppm 2 hours	No	FVC	$P <.05$
			$FEV_{.75}$	$P <.05$
			MMEF	Not significant
Hazucha *et al.* (A6)	0.75 ppm 2 hours	Yes[1]	FVC	$P <.05$
			FEV_1	$P <.01$
			MMEF	$P <.05$
Kagawa and Toyama (A7)	0.9 ppm 5 minutes	No	Gaw/Vtg	Not significant
	0.9 ppm 5 minutes	Yes[2]	Gaw/Vtg	$P <.01$

---

[1] Fifteen minutes on ergometer, sufficient to double minute-volume.

[2] Pedaling at 50 rpm for 5 minutes at a load of 100 kg - m/min.

O_3, NO_2, and CO (A8, A9). These studies are summarized in Table A-VII.

Sulfur dioxide. - The study by Andersen et al. (A10) was done to evaluate the SO_2 threshold limit value, TLV, of 5 ppm for occupational exposures. Concentrations (1, 5 and 25 ppm) involved in this study are much higher than ambient levels except 1 ppm level may possibly be reached in episodic conditions. However, some of the conclusions of this study are interesting. Figure A-4 shows that the effect on FEV_1 of high concentrations of SO_2 is minimal. The changes in MMEF are somewhat larger. The dose-response curves are nonlinear and twenty-five percent the change at 25 ppm in MMEF occurs at one ppm and after one ppm the changes are almost linear. It is possible that this initial steep change could occur at concentrations well below 1 ppm. Another interesting finding in the Anderson et al. study was that changes in closing volume were not significant even at high concentration, implying that SO_2 may effect only the upper airways.

Ambient air. - In an unusual study with experimentally controlled six-day exposure to ambient air no meaningful differences were observed between clean and ambient air phases (A11). The subjects breathed clean filtered air for the first three days and ambient air for the last three days of the six-day exposure. In the second experiment this order was reversed; ambient air was breathed for the first three days and clean filtered air for the last three days. Other variables such as temperature, humidity and sleep-awake cycle were rigidly controlled.

The results of the study implying "no effect" due to ambient air

TABLE A-VII. SEQUENTIAL EXPOSURE OF OZONE, NITROGEN DIOXIDE AND CARBON MONOXIDE TO ADULT MALES.

Study	Population	Pollutant and Exposure	Results
Hackney (A8)	4 - normal	1st day: 0.5ppm O_3 2nd day: 0.5ppm O_3 + 0.3 ppm NO_2 3rd day: 0.5ppm O_3 + 0.3 ppm NO_2 + 30 ppm CO (four-hour exposures)	Changes small in magnitude and not consistent
Hackney (A9)	1 - normal 5 - 'reactive'	1st day: 0.25 ppm O_3 2nd day: 0.25 ppm O_3 + 0.3 ppm NO_2 3rd day: 0.25 ppm O_3 + 0.3 ppm NO_2 + 30 ppm CO (two-hour exposures)	FEV_1 and FVC decreased with O_3 + NO_2 (day 2), no significant changes in other measurements.

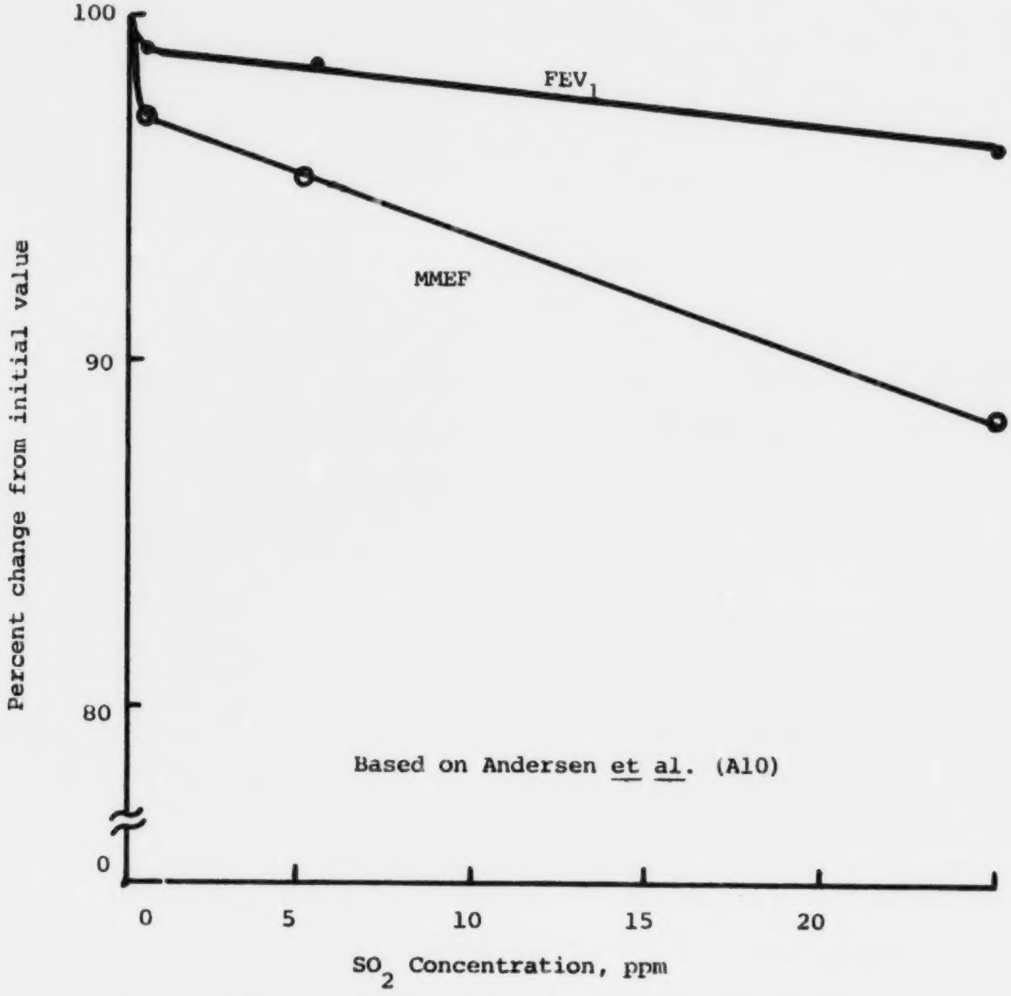


Figure A-4. Dose-response curves for adult males for six-hours of exposure to SO_2.

pollutants were not surprising since the concentrations of air pollutants in the "ambient air" phases of the study were substantially lower (possibly 60-70 percent lower) than actually prevailing outside (A11, A15).

Although the results of the Kerr study (A11) were negative, it offers useful information for future studies (see the section on comments).

EPIDEMIOLOGICAL STUDIES: GROUP 1 - CORRELATION STUDIES (A16-A20)

Details

The details of the studies are given in Table A-VIII. The timespan of this group of epidemiological studies were a few weeks to one year in length. In most of the studies PFT observations were made once a week, whereas enrivonmental variables were continuously being monitored. Two of the more recent studies (A19, A20) seemed to have monitored all six of the air pollutants for which ambient air quality standards exist. It is recognized that the term "all of the pollutants" is relative; the list of air pollutants is expected to grow with time and newer pollutants are continually being recognized and studied. Thus it must be noted that in the mid 1960's oxidants and nitrogen oxides were not thought to be a problem outside Los Angeles area, also routine methods for monitoring these pollutants may have been unavailable. However, for the sake of comparison of the results of these epidemiologic studies, it was necessary to define the "pollutants not included" (Table A-VIII).

TABLE A-VIII. EPIDEMIOLOGICAL STUDIES: GROUP 1-CORRELATION STUDIES.

Studies / Parameters	Spodnik *et al.* (A16)	Spicer *et al.* (A17)	Emerson (A18)	Kagawa and Toyawa (A19)	Kagawa *et al.* (A20)
Study period[1]	Sept'64 June'65.	two 7 week study periods 1965-1966.	1969-1971	June-Dec. 1972.	Nov 1972- Oct 1973.
frequency of observations	weekly	daily	weekly	weekly	weekly
Pollutants studies	PM	PM, SO_2, NO_2	PM[2], SO_2	PM, SO_2, NO NO_2, HC, Ox, O_3	PM, SO_2, NO_2 Ox
Pollutants not included[3] (which could possibly have interference effects)	SO_x, NO_x	Ox	NO_x, Ox[4]	---	---
Other stressors studied[5]	T, RH	T, RH, BP, WS	T, RH, BP, WS	T, RH	T, RH
Pulmonary function tests					
FVC, TLC	TLC	FVC, TLC	FVC	FVC	FVC
FRC, RV	FRC	FRC, RV		FRC	FRC
FEV_t		FEV_1, FEV_3	FEV_1		
PEF		PEF	PEF		
MMEF			MMEF		
$MEF_{\%VC}$				MEF_{50}, MEF_{25}	MEF_{50}, MEF_{25}
MEFV Curves				MEFV Curves	MEFV Curves
CV					
Raw, Vtg[6]	Raw, Vtg[7]	Raw, Vtg[7]		Raw, Vtg	Raw, Vtg
Cst, Cdyn					
Other			Max inspiratory flow rate	Slope of alveolar plateau (N_2%)	
Population	100 male adults average age 20 years	27 patients with chronic bronchitis and bronchial asthma	18 patients (14 males, 4 females) with chronic airways obstruction	20 children (10 males, 10 females), average age 11	20 children (10 males, 11 females), average age 11

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[1] As reported in the particular study or estimated based on the date of publication.
[2] As smoke in μg/m^3.
[3] See text for explanation.
[4] British studies, generally, include only smoke and SO_x as pollutants. It is possible that due to automobile traffic, nitrogen oxides and oxidants could be present in the London atmosphere.
[5] T - temperature, RH - relative humidity, BP - barometric pressure, WS - windspeed.
[6] Gaw/Vtg is calculated from Raw and the thoracic volume.
[7] Upper and lower airway resistance and lower airway conductance were also calculated.

All of the studies have monitored other environmental stressors such as temperature and relative humidity. Most of the studies have an adequate characterization of the pulmonary function including characterization of both upper and lower airways. Finally, a good spectrum of segment of population has been studied including healthy adults and children, as well as patients with chronic obstructive pulmonary diseases.

Results

Larger number of variables were involved in this group of five epidemiological studies than in the group of experimental studies. The results of these studies were less conclusive than the experimental studies.

All of the studies attempted to obtain correlation between environmental variables and results of the pulmonary function tests. Ambient temperature seemed to have the strongest correlation with changes in pulmonary function. With decrease in temperature, air-way resistances increased (A17, A20) and MEF_{50} decreased (A20). Increase in temperature appears to have a dilating effect on both upper and lower airways. Among other environmental variables, windspeed and humidity had some effect on the pulmonary function.

In pre-1971 studies only one study (A17) was able to show some correlation between concentration of air pollutants (SO_2) and decrease in FEV_1. Even in this case, the correlation may be due to very high SO_2 levels (peak concentration of .45 ppm) experienced in one segment of the study. It appears that absence of significant correlations between concentration of air pollutants and pulmonary function could be due to the fact that all the pollutants were not monitored. This observation seems to be substantiated by two of the more recent studies (A19, A20).

In two studies (A19, A20) performed in Japan on 11-year old children, pollutants such as oxidants and nitrogen oxides were monitored in addition to particulates and sulfur dioxide. Characterization of pulmonary function was also more extensive as compared to the pre-1971 studies. Ozone and nitrogen dioxide seemed to have effect on the upper airways of majority of the children during the period November to March (low temperature season in Japan). Concentrations of NO, SO_2, and PM correlated well with MEF_{50} and MEF_{25} which are reflectors of changes in the lower airways.

Finally, Kagawa et al. (A20) has found a dose-response relationship between concentration of NO_2 and MEF_{50} (Figure A-5). Although R^2 of this regression exercise is small (0.20), this is the only air-pollution-related dose-response relationship which has resulted from this group of epidemiological studies.

EPIDEMIOLOGICAL STUDIES: GROUP 2 - CROSS-SECTIONAL STUDIES (A21-A25)

Details

The details of six epidemiologic cross-sectional studies are shown on Table A-IX. Although some of the studies were done over a period of two or three years, the main aim of each of these cross-sectional studies was to compare the effects on similar segments of population of the differentials in air pollution prevalent in two or more areas.

Particulates and SO_2 were the only pollutants considered in three

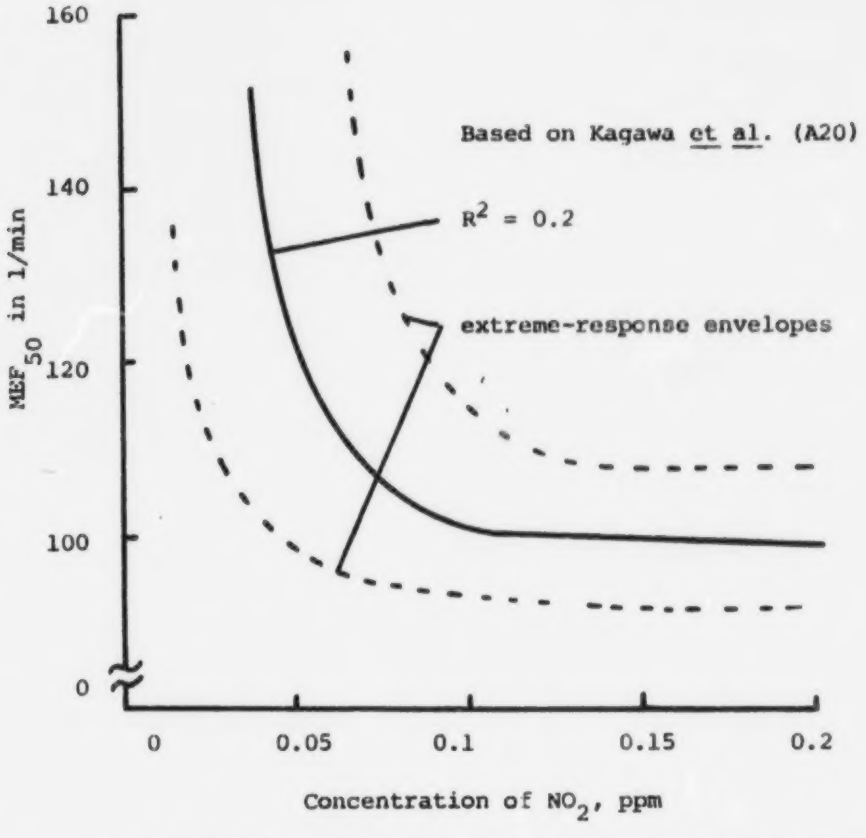

Figure A-5. Dose-response curve of nitrogen dioxide for children of age eleven years.

TABLE A-IX. EPIDEMIOLOGICAL STUDIES: GROUP 2 - CROSS-SECTIONAL STUDIES

Parameter / Studies	Anderson and Ferris (A21)	Lunn et al. (A22)	Shy et al. (A23, A24)			Mostardi (A25)
Locations and study period	Berlin, N.H.: 1961, Chilliwack, B.C. Canada: 1963	Sheffield, England: Summer terms 1963-65	Chattanooga: 1968-69 school year	Cincinnati: 1967-68 school year	New York: 1970-71	Barberton and Revere, Ohio: 1970-73
Pollutant studied	PM,[1] SO_2[2]	PM,[3] SO_2	PM, SO_2, sulfates, NO_2, nitrates	PM, SO_2, sulfates	PM, SO_2, sulfates, NO_2	PM, SO_2[2]
Average concentration of pollutants in low pollution areas as a percent of the same in high pollution areas	PM, 29 SO_2, 8	PM, 31 SO_2, 50	NO_2, 64	PM, 64	PM, 49 SO_2, 46 Sulfates, 77 NO_2, 37	PM, 70 SO_2, 78
Interference factors studied	Smoking	Socioeconomic, siblings	Socioeconomic, sex, month of testing	Socio-economic sex, race	Socio-economic, sex, age group	Race
Pulmonary function tests						
FVC	FVC	FVC				FVC
FEV_t	FEV_1	$FEV_{.75}$	$FEV_{.75}$	$FEV_{.75}$	$FEV_{.75}$	$FEV_{.75}$ (FEV_1 in 1970)
PEF						
MMEF						MMEF (in 1970)
Population	Berlin, N.H. (high pollution) 1261 adults, ages 25-74 years Chillawack, B.C. (low pollution) 558 adults, ages 25-74 years	Four areas of Sheffield (one in low, 3 in high pollution areas) 819 children, average age, 5 years	Four areas of Chattanooga 987 children, ages 7-8 years	Several areas of Cincinnati 394 children, ages 7-8 years	Several areas of low, intermediate and high pollution 2364 children, ages 5-13 years	Barberton (higher population) 50 children, average age, 14 years

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[1] PM mean and as dustfall.

[2] In these studies, SO_2 levels were estimated from lead sulfation rates.

[3] PM measured as smoke.

studies (A21, A22, A25). The other three studies done under the U.S. Environmental Protection Agency's Community Health and Environmental Surveillance System (CHESS) program monitored pollutants such as NO_2, sulfate, nitrates, in addition to PM and SO_2 (A23, A24).

A very limited number of pulmonary function tests have been used in all of the studies. A majority of studies including the CHESS studies chose to use $FEV_{.75}$ which is thought to be a less sensitive indicator of changes in lower airways. One of the factors that might have influenced choice of the test could be the large number of subjects studied. In five out of six studies, size of the population sample was of the order of several-hundred. Similarly, in a majority of the studies effects on children were studied.

Results

All of the studies are able to show some differences in pulmonary function between groups of subjects who were exposed to "high" and "low" levels of air pollution. In one of the early studies, Anderson and Ferris (A21) found significant differences in FEV_1 and PEF in residents of Berlin, New Hampshire and Chilliwack, British Columbia. Berlin being a manufacturing center of pulp, paper and paper products had levels of SO_2 twelve times that of Chilliwack, which is situated in an agricultural area. The differences in FEV_1 and PEF were significant even after controlling for age, height, sex, and smoking habits. In this study, PEF appeared to be a somewhat more-sensitive indicator than FEV_1 (A21).

In the case of children, most of the studies are able to show small but significant differences between low and high air pollution exposure areas (A22, A25). The differences in pulmonary function between low and high pollution have been gradually decreasing over the years as the air pollution levels in higher pollution areas have been decreasing (A24, A25).

Results of these studies are less conclusive than the results of the first two groups of studies. It is felt that the pulmonary function tests such as $FEV_{.75}$ may not be a sufficiently sensitive indicator for observing effects of air pollution.

EPIDEMIOLOGIC STUDIES: GROUP 3 - LONGITUDINAL STUDIES (A26-A31)

Details

Longitudinal studies on the long-term effect of air pollution on pulmonary function were conducted (Table A-X) by two groups of investigators: Lawther *et al*. (A26-A28) and Ferris *et al*. (A29-A31). These studies were five to ten years in length. Lawther *et al*. (A26-A28) performed pulmonary function measurements almost daily on a small number of individuals. The second group of studies done in the U.S., by contrast used a large sample of population. In the Berlin, New Hampshire study, Ferris *et al*. (A29-A31) took spirometric measurements twice: once at the beginning of the study in 1961 and then at the end of the study in 1967. Particulates and SO_2 were the only two pollutants monitored in all of these studies.

Results

Results of this group of studies were less conclusive than the first three groups of studies. Lawther *et al*. (A26,A27) found small but

TABLE A-X. EPIDEMIOLOGICAL STUDIES: GROUP 3 - LONGITUDINAL STUDIES

Parameters	Lawther et al. (A26,A27)	Lawther et al. (A28)	Ferris et al. (A29,A30,A31)
Study period	1960-65, 69	Variable[1]	1961-67
Location	London, England	London, England	Berlin, N.H.
Frequency of observations	Daily	5/day	Once in 1961 and in 1967
Pollutants studied	PM,[2] SO_2	PM,[2] SO_2	PM, SO_2
Inteference factors considered	Respiratory infections	Respiratory infections	Smoking, Occupational, Residential
Pulmonary function tests			
FVC	FVC		FVC
FEV_t	$FEV_{.75}$, FEV_1		FEV_1
PEF	PEF	PEF	PEF
MMEF	MMEF		
Other			Questionnaire similar to Medical Research Council (England)
Population	4 non-smokers, ages 30-41 years (Subjects their own controls)	2 bronchitis patients, 2 normal males (Subjects their own controls)	700 adults, ages 25-74 yrs. Two studies: (1) follow-up in 1967 of the sample studied in 1961; (2) random samples both in 1961 and in 1967.

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[1] One bronchitis patient was studied from 1964 to 1970; another only in 1962. In case of the normal subjects, measurements are reported for 1963-64 only.

[2] PM as smoke.

consistent seasonal changes in FEV_1 and in PEF (winter values 1.5 percent lower than summer). Changes in pulmonary function over a period of years were less consistent. In fact, there was a gradual increase (1.5 percent) in PEF over five years whereas a decrease of about 0.3 percent per year due to age would be expected. One possible reason: performing the respiratory function tests daily may have had the effect of "training".

Reduction in air pollution from 1961 to 1967 in Berlin, New Hampshire (by approximately 20 percent in particulates and 30-40 percent in sulfur oxides) showed some increase in FVC and PEF and inconsistent changes in FEV_1 (A31). Repiratory infections (A27,A28) and smoking (A29, A31) appear to be strong factors in influencing changes in pulmonary function.

MMEF showed the most consistent association with air pollution as compared to FVC, FEV_1 and PEF (A26,A27). The use of less-responsive tests may be one of the important reasons for the inconsistent results obtained for the long term effect of air pollution on the pulmonary function.

COMMENTS

The preceding reviews affirm the recognized complexity of the problems of interactions of exposure to air pollution and the difficulties inherent in the design of studies to measure the effects of air pollutants on human health. It is natural that any document or studies dealing with the problem of how air pollution affects health would draw criticism. On the other hand, almost all of the studies, even those not having any consistent positive results, provide useful insights into the complex problem. The purpose of this section is to review and discuss such subtle points as well as specific difficulties associated with both experimental and epidemiological studies, and to develop recommendations for methodologies and techniques for future studies. The following discussion on exposure chamber studies is specifically related to experimental studies, subsequent discussion is common to both experimental and epidemiological studies.

Exposure-Chamber Studies

Studies with artificially generated pollutants have been performed more frequently than those involving exposure to ambient air pollution. Even in the case of artificially generated pollutants, exposure to single pollutants are studied more often than exposure to multiple pollutants. It is very difficult to realistically duplicate actual exposure conditions with artificially generated single pollutants and much more difficult to do so with multiple pollutants. The concept of experimentally controlled exposure to ambient air which allows simultaneous exposure to several pollutants present in the atmosphere is thus very attractive. In practice, however, the experimentation with ambient air pollution poses several problems.

Among the environmental variables, temperature may have a greater effect on the pulmonary function than the air pollutant of interest. Therefore, temperature must be rigidly controlled in experimental studies. A substantial portion of particulates present in the ambient air may be removed in the process of controlling temperature and humidity or in the conditioning of ambient air. Similarly, once inside the exposure chamber, pollutants such as SO_2 or Ox may decay rapidly. In the only study with ambient air, oxidants were not monitored. The levels of SO_2 were 6 to 62 percent (average 33 percent) of those actually prevailing outside.

To circumvent the problems with ambient air, artificially generated pollutants are used. With artificially generated pollutants, replication of levels of O_3, SO_2, NO, NO_2 is possible but replication of concentration and composition of particulates would be difficult. Similarly total oxidants include ozone and other oxidants and even though exact levels of ozone could be achieved, it would be very difficult to replicate the total oxidants in exposure chambers. Pros and cons of the artificial or ambient air pollutants have to be considered before deciding on a specific experimental study.

Monitoring of Air Pollutants

Adequate characterization of all the air pollutants is extremely important. Generally, studies which adequately monitored pollutants have been able to show consistent and distinct effect of air pollutants. Unfortunately, only four (A19,A20,A23,A24) out of the 15 non-experimental studies have adequately characterized the six air pollutants present in the ambient air. It is recognized that at the time when some of the studies were done (early or mid 1960s), routine methods for monitoring of pollutants such as NO_x, Ox, were not available. However, even in some of the more recent studies (A11,A25) air pollutants have not been adequately characterized and monitored.

The list of identified pollutants is expected to grow. Similarly the techniques for measurement have been and will be improved with time. For example, even the reference method for NO_2 had to be changed recently due to its variable efficiency over the concentration measurement range (A32). The following table gives methods for measurement of various gaseous pollutants (A33).

TABLE A-XI. SOME OF THE ACCEPTABLE METHODS FOR MONITORING OF GASEOUS AIR POLLUTANTS.

Pollutants	Method based on
SO_2	Colorometric Coulometric Flame Photometric
NO_2	Colorometric Chemiluminescent
O_3	Chemiluminescent UV Absorption
CO	Flame ionization using gas chromatograph Nondispersive infra-red
HC	Flame ionization using gas chromatograph

In the case of particulates, hi-volume sampler for measurement of total suspended particulates is a minimum requirement. However, it reveals nothing about size or species. Deposition of particles in the lung depends on particle size and thus hi-vol measurements should be supplemented with measurement of particle-size distribution (A34). Similarly, the chemical analysis of particulates (A35) should be carried out in order to provide useful information for correlation with health effects.

Pulmonary Function Tests

The distribution of the use of different pulmonary function tests among the four groups of studies is interesting (Table A-XII). The first two groups of studies, i.e., experimental and epidemiological-correlation studies, have almost equal use-distribution of the different PFTs, although experimental studies have used FEV_1, MMEF, CV, Cst and Cdyn, etc., more frequently. In the remaining two groups of epidemiological studies FEV_t, FEV, and PEF or the PFTs which characterize function of upper airways were used more often.

As mentioned earlier in this review cross-sectional and longitudinal epidemiological studies have less consistent results than the experimental and epidemiological-correlation groups of studies. A larger number of variables are involved in epidemiological studies and thus the results are expected to be less conclusive or clear-cut as compared to the studies done under more controlled experimental situations. However, it is felt that one of the reasons for less conclusive results of the last two groups of studies could be an inadequate characterization of pulmonary function or use of less-sensitive PFTs. A brief review on sensitivity of the different PFTs follows.

Sensitivity.- Macklem and Mead (A36) have demonstrated that the major site of resistance to air-flow in the normal tracheobronchial tree is in the larger or central airways (> 2mm). The smaller or peripheral airways

TABLE A-XII. DISTRIBUTION OF THE USE OF PULMONARY FUNCTION TESTS IN THE STUDIES REVIEWED

Group	Total Number of Studies in Each Group	FVC	FEV_t	PEF	MMEF	$MEF_{\%VC}$	MEFV Curves	CV	Raw, Vtg	Cst Cdyn
Experimental studies (A3-A11)	9	6	8	5	5	2	4	4	4	3
Epidemiological studies:										
Group 1 - correlation (A16-A20)	5	4	2	2	1	2	2		4	
Group 2 - cross-sectional (A21-A25)	6	3	6	1						
Group 3 - longitudinal (A26-A31)	3	2	2	3	1					

(< 2mm), in contrast, appear to contribute very little to overall resistance. The importance of this finding is that early airways obstruction involving smaller airways may be present and smouldering for many years before it becomes extensive enough to cause measurable changes in air flow by conventional spirometric tests such as FEV_1, FVC, PEF, etc. (A37). Similarly, early effects of air pollutants could be on smaller airways and thus characterization of smaller airway function is essential.

The ability to detect early airways obstruction would appear to depend on the use of a technique which is capable of measuring changes at the small airways. Such techniques include closing volume, MEFV curves, frequency dependence of compliance as well as the spirometric tests such as MMEF, MEF_{50}, and MEF_{25}. The measurement of compliance is a useful technique but it requires complex and costly equipment and, due to somewhat unstable measurements, it may not be suitable for routine use.

The maximum expiratory flow volume (MEFV) curves allow analysis of flow at both high and low lung volumes. Analysis of flow at low lung volumes is particularly important in detection of early obstruction (A38). Bouhuys (A39) stresses that recording MEFV curves can be rigorously standardized, quality-controlled by computer software, and suitable for routine use. In fact, in an air pollution-effect study of 111 children, Zapletal _et al_. (A40) showed use of MEFV curves to be a sensitive and valuable test.

Measurements such as MMEF, MEF_{50}, and MEF_{25} are also suitable since they provide flow rates at low lung volumes (A41). McFadden and Linden (A42) showed that even when tests such as Raw, FEV_1, PEF and TLC were all within the predicted statistical norms, low MMEF represented significant airways obstruction in peripheral bronchioles. Cochrane et al. (A43) found that in a group of 21 smokers with relatively normal values of FEV_1, over 60 percent of these individuals had abnormal values of MEF_{75}, MEF_{50} and FET.

The measurement of closing volume is a simple and sensitive test for the obstruction of smaller airways. It is also considered to be well suited for routine use in a pulmonary function laboratory or as a screening tool in epidemiological studies (A44,A45). However, in one study (A43) for 9 out of a total of 21 subjects there were difficulties in the intrepretation of tracings of closing volumes. Similarly for closing volume measurements the range of the normal values is large which tends to diminish the usefulness of the technique (A46).

The above comments on the relative-insensitivity of conventional spirometric tests (FVC, FEV_1, PEF) to detect minor abnormalities in small airways and to detect effects of air pollution are in essence the same as those made in 1968 by Bates (A47) and by Frank (A48). The choice of appropriate and sufficiently sensitive PFTs may determine the potential for results of a given air pollution-effect study. For adequate characterization of pulmonary functions, a combination of tests that are sensitive to lower airways (such as MEFV curves, MMEF, MEF_{50}, MEF_{25}, FET) as well as tests that are predominantly for detecting resistance in upper airways (FEV_1, PEF) should be used.

Interference factors. - There are many factors which could interfere with a measurement of effects of air pollutants with pulmonary function tests. Smoking, respiratory illnesses, as well as environmental factors such as temperature have considerable influence on the results of pulmonary function tests. A reduction of 8 percent in PEF was noted in one study (A26) following a respiratory illness and the magnitude of changes due to infections was large as compared to observed seasonal variations. Thus, in any air pollution-effect study even trivial illnesses such as the common cold must be recorded.

Smoking, not surprisingly, has an overwhelming influence on pulmonary function measurements (A21). In the analysis of an air pollution-effect study, particularly, in case of a cross-sectional study, not only is it required to treat smokers and nonsmokers as different groups, but within the smoking group, light or non-inhalers versus inhalers, as well as number of cigarettes per day should also be noted.

Substantial diurnal variations (20-40 percent) are present in some of the pulmonary function measurements. Lowest Gaw/Vtg as well as lowest PEF in a 24-hour period were recorded during early morning (0300-0600 hours) in two separate studies (A11,A28).

As discussed earlier, several studies have shown that ambient temperature has a strong influence on the pulmonary function (A16-A19). Sometimes it is difficult to separate the effects of temperature and of an air pollutant such as SO_2 (A49). Both a decrease in ambient temperature or an increase in the SO_2 concentration causes a reduction in pulmonary function. Thus the separation of the effects of the two variables is especially difficult for winter months since as the temperature decreases the concentration of SO_2 increases because of the increased combustion of sulfur-containing fuels for space heating.

Finally, daily measurement of pulmonary function may have a "conditioned training" effect which may distort any trend analysis of the measurements (A27). Thus, frequency of observations should not be greater than once a week in long term longitudinal studies.

Population

In a number of studies it was observed that some individuals in almost all of the groups of subjects that were studied were hyperreactive to environmental changes. Table A-XIII shows the number of hyperreactive individuals and the total sample in various studies. Although none of the population samples was truly random, it is interesting to note that 10-50 percent of any segment of population including children, adults, and individuals with lung disease could be hyperreactive to air pollution and other environmental factors. These individuals, in general, may be expected to show stronger clinical symptoms in case of respiratory infection.

Sensitivity to respiratory infections may not be the only factor responsible for hypersensitivity. However other factors for distinguishing individuals hypersensitive to air pollution are not known. In the Hackney _et al_. (A9) study, one-third of the individuals who were not thought to be sensitive before the study showed hypersensitivity to air pollution. Conversely, not all of the patients with chronic obstructive pulmonary diseases were hypersensitive to air pollution (A18).

TABLE A-XIII. PROPORTION OF HYPERREACTIVE POPULATIONS IN SELECT EXPERIMENTAL AND EPIDEMIOLOGICAL STUDIES.

Study	Population Sample	Number of Hyperreactive Individuals	Hyperreactive as Percent of Total Sample
Emerson (A18)	18 adults with COPD[1]	7	39
Kagawa *et al.* (A20)	20 children	6	30
Lawther *et al.* (A26)	4 adults	1	25
Hackney *et al.* (A9)	13 adults	7	54
Bates *et al.* (A3)	11 adults	1	9

[1] Chronic obstructive pulmonary disease

ASSESSMENT OF HEALTH-EFFECT STUDIES

Rationale

The optimally designed study should include: (a) monitoring of all air pollutants permitted by the "state-of-the-art", including those pollutants which are not specifically being studied, (b) use of sufficiently sensitive tests for adequate characterization of effects on pulmonary function, (c) elimination of or accounting for interference factors, and (d) at least a part of population sample consisting of hypersensitive persons. These factors also permit a rational evaluation of the relative merit of the methodologies used in past studies for an assessment of present status of research and future needs. In determining the relative merit of methodologies, the degree of resolution and the quality of the results were considered to be of significant importance. The rationale was that the results of air-pollution-effect studies in the form of cause and effect relationships would have good resolution (i.e., significant differences in measurements for the control values) and be of an acceptable quality if cause, effect, and interference factors are defined with sufficient detail and if a sensitive population sample is used.

Approach

For the evaluation of relative merits of methodologies only two of the previously listed factors: characterization of air pollutants and use of sensitive pulmonary function tests are considered. The other two factors would provide more stringent criteria but were not used in this assessment. The approach was to individually rank the two factors for each of the studies based on the following criteria:

		Ranking
(a)	Characterization of air pollutants	
(i)	all air pollutants adequately monitored	1
(ii)	study-pollutants adequately monitored, but inadequate characterization of other pollutants	2
(iii)	inadequate characterization of the study pollutants	3
(b)	Characterization of pulmonary function	
(i)	at least one PFT for characterization of smaller airways (Cst and Cdyn, MEFV curves, MMEF, MEF_{50}, MEF_{25}, FET, CV, etc.) and one PFT for upper airways (FEV, PEF, Raw/Vtg, etc.)	1
(ii)	at least one PFT for smaller airways	2
(iii)	no PFT for smaller airways	3

In ranking the degree of resolution and reliability of the results for a given study, the lower of two rankings for characterization of air pollutants and pulmonary function was considered to be the appropriate one. The reason for selecting the lower ranking was that since these studies evaluate the relationship between two interdependent variables, both factors have to be characterized equally well. For example, in Young et al. (A3) the characterization of both air pollution and lung function meet the criteria of rank one and, thus, this study was rated to have a high degree of resolution and reliability in its results.

Conversely, in the study with experimental exposure to ambient air (All), even if characterization of pulmonary function were ranked as one, all air pollutants were not monitored and thus this study was rated to have a low degree of resolution and reliability in the results. A similar approach was used for evaluating all the studies and totals for each group of studies are presented:

TABLE A-XIV. RESULTS OF ASSESSMENT OF THE HEALTH-EFFECT STUDIES.

Studies	Number of studies	Degree of resolution of and reliability in the results of studies: High	Intermediate	Low
Experimental studies	9	7	1	1
Epidemiologic studies				
Group 1 - Correlation	5	2	3	0
Group 2 - Cross-sectional	6	0	0	6
Group 3 - Longitudinal	3	0	1	2

Results

Table A-XIV shows that most of the experimental studies had adequate monitoring of air pollutants as well as of pulmonary function. Approximately half of epidomiologic-correlation studies had potential for a high degree of resolution and reliability in results. Most of the cross-sectional and longitudinal epidemiologic studies had either a poor characterization (rank 3) of air pollutants or of pulmonary function and consequently most of these studies were rated as having a low degree of resolution and reliability.

The above observations are generally the same as one would get from reviewing the results of different studies which were discussed in preceding sections. Experimental studies have yielded dose-response relationships for ozone. This should not imply that no additional research is necessary or that generalized dose-response curves can be constructed from available information, but it is clear that, with adequate characterization of air pollution and the effects on pulmonary function, experimental studies have yielded conclusive and useful results. Similarly, epidemiological correlation studies have shown correlations between the environmental and pulmonary function variables. In addition, one of the correlation studies has been able to show a tentative dose-response curve for NO_2. The results from the last two groups of epidemiologic studies are less reliable and the conclusions are less clear. The reason for this could be inadequate characterization of air pollution as well as of pulmonary function.

The important conclusion that can be drawn from this assessment is that the lack of epidemiological dose-response data is not due to lack of studies, but is due to a lack of results or data with high degree of reliability.

CONCLUSIONS

Numerous studies of the health effects of air pollution have used pulmonary function tests for the characterization of effects on a human lung. Enough data for construction of generalized dose-response curves are not available. Thus the tolerance factors derived from the air quality standards still represent the best available approach for a relative assessment of the deleterious effects of simultaneous exposure to any combination of the six pollutants.

Short term effects of ozone with exposure-duration of up to four hours have been extensively studied. Figures A-1 and A-3 show dose-response relationships in terms of pulmonary function measurements for ozone. Short term effects of other pollutants as characterized by pulmonary function tests have received little study. Epidemiologic studies involving cross-sectional and longitudinal analysis have not been very fruitful beyond showing a qualitative association between air pollution and decrease in the pulmonary function.

Many factors interfere with a plausible demonstration of the relationship between air pollution and its effects. Effects on pulmonary function of ambient temperature, smoking, and respiratory infections overwhelm the possible effects of air pollution. A number of studies have identified some of the individuals in the population sample as hyperreactive or hypersensitive to air pollution.

The importance of adequate characterization and monitoring of all the air pollutants and adequate characterization of pulmonary function cannot be overstressed. For any future study to be productive in terms of conclusive results, the study must monitor all the air pollutants, use sensitive tests for measurement of the pulmonary function, eliminate or account for all the possible interference variables and finally, include in the population sample a group of population who are hypersensitive to air pollution.

In the future, experimental studies involving exposure of several days to concentration of ozone and sulfur dioxide which are lower than previously studied such as 0.1-0.3 ppm of ozone and 0.05-.5 ppm of sulfur dioxide and other pollutants with concentrations near the ambient standards deserve a priority. In the case of the air pollution-epidemiological research, the studies aimed at quantifying long-term (5-15 years) longitudinal effects of air pollutants are needed.

Finally, at the risk of being repetitive, future epidemiologic studies must take into account all of the factors discussed above. Failure to do so in this area of complex research will diminish the value of the results obtained.

APPENDIX A

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APPENDIX B

LISTING OF THE COMPUTER PROGRAM

```
C
C****************************************************************************
C
C       SOURCE RANKING PROGRAM WRITTEN BY NIREN L. NAGDA & GLENN F. KERBS
C       JUNE 1975
C
C****************************************************************************
C
        COMMON /OPT/ JOBOP,DSC,TF(5),FF(5),WIND,THET,SIGMY,SIGMZ
       1,JOB
        COMMON /A1/ NC,IC(2300)
        COMMON /SD/ ISN(11),NST(11),NS2(11)
        COMMON /BIG/ SOURCE(16000),MX(881,4)
        COMMON /LEF/ IUI(11),X(11),Y(11),POP(11),AREA(11),ICO(11,2),
       1 DIST(11,11)
        COMMON /IMP/ BCON(11,11),CCON(11),EXPC(2300),EXPA(11)
        COMMON /VAL/ EMSS(2300),PIND(2300),POPEXP(2300)
        JOBGF=0
         JOBCF=8
        JOBCP =11
        JCB=0
        JUMP=0
C
C       INITIALIZE SENSITIVITY VARIABLES
C
    1   DSC=1.0
        WIND=5.
        THET=1.
        SIGMY=1.
        SIGMZ=1.
        FF(1)=54.
        FF(2)=41.
        FF(3)=53.
        FF(4)=2900.
        FF(5)=104.
        DO 5 K=1,5
      5 TF(K)=FF(4)/FF(K)
        IF(JUMP .EQ. 1) GO TO 20
        NC=11
C
C       THE FOLLOWING CODE SETS UP THE DATA STRUCTURES OF THE PROGRAM
C
        READ(5,10) ISN
C
C       ELEMENT I OF ARRAY ISN HOLDS THE NUMBER OF SOURCES IN COUNTY I
C
        NST(1)=1
        NS2(1)=1
        DO 15 I=2,11
C
C       THE ARRAY NS2 ALLOWS THE FUNCTION NAND TO SIMULATE THE ACCESSING
C       EASE OF A 2 - DIMENSIONAL ARRAY WHILE KEEPING THE STORAGE
C       COMPACTNESS OF A 1 - DIMENSIONAL ARRAY
C
        NS2(I)=ISN(I-1) + NS2(I-1)
C
C       THE ARRAY NST ALLOWS THE FUNCTION ISUB TO SIMULATE THE ACCESSING
C       EASE OF A 3 - DIMENSIONAL ARRAY WHILE KEEPING THE STORAGE
```

```
                C      COMPACTNESS OF A 1 - DIMENSIONAL ARRAY
                C
0032               15 AST(I)=ISN(I-1)*7 + AST(I-1)
0033                  CALL DATAR
0034                  CALL DISTAN
0035                  CALL FINDEX
0036                  CALL MASSE
0037                  CALL CCRIBC
0038                  CALL SUMDIS
0039                  CALL RITEA
0040                  JUMP=1
0041               20 JCROP=JCROP+1
0042                  IF (JCROP .EQ. 12) GO TO 25
0043                  CALL SENSE
0044                  GO TO 1
0045               25 STOP
0046               10 FORMAT(11I5)
0047                  END

 *OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
 *OPTIONS IN EFFECT*  NAME = MAIN    , LINECNT =        50
 *STATISTICS*    SOURCE STATEMENTS =        47,PROGRAM SIZE =       548
 *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
      SUBROUTINE CORIEO
      COMMON /SD/ ISK(11),NST(11),NS2(11)
      COMMON /BIG/ SOURCE(1600),MX(661,4)
      COMMON /CPT/ JOBCP,DSC,IF(5),FF(5),WIND,THET,SIGMY,SIGMZ
     1,JOB
      COMMON /AT/ NC,IC(2300)
      COMMON /VAL/ EMSS(2300),PIND(2300),PGPEXP(2300)
      COMMON /IMP/ BCON(11,11),CCON(11),EXPC(2300),EXPA(11)
      COMMON /LEF/ IUI(11),X(11),Y(11),FUP(11),AREA(11),ICG(11,2),
     1 DIST(11,11)
      REAL KMDIST
      DO 150 I=1,2300
  150 EXPC(I)=0.0
      DO 1 I=1,NC
      CCON(I)=0
      DO 2 J=1,NC
    2 BCON(I,J)=0
    1 CONTINUE
      DO 5 I=1,NC
      DO 10 J=1,NC
      IF(DIST(I,J) .LE. 0.) GO TO
      IS=ISK(I)
      IF(IS .EQ. 0) GO TO 5
      DO 15 N=1,IS
      IND=ISCD(I,N,7)
      IF(SOURCE(IND) .LE. 0.) GO TO 15
      H=SOURCE(IND-1)
      JA=J
      IA=I
      IF (IA.EQ. JA) GO TO 31
      KMDIST=DIST(I,J)  *1.6
      GO TO  33
   31  HLO=0.
      IF(H .LE. 1.) GO TO 32
      HLO=ALOG(H)
   32 KMDIST = DSC*(1.6 *  .259*ABS(SQRT(AREA(I)/3.1416))+ .024*H +
     1  .512*HLO- 0.645)
   33 D=KMDIST
      DL=-.8*ALOG(D)+14.3
      IF(D .GT. 4.) GO TO 21
      IF(H .GE. 0 .AND. H .LT. 10.0) GO TO 23
      IF(H .GE. 10. .AND. H .LE. 100.0) GO TO 24
      IF(H .GE. 100. .AND. H .LE. 250.) GO TO 25
      IF(H .GT. 250.) GO TO 100
   21 THETA=DL
      GO TO 22
   23 IF(D .LT. .2) GO TO 100
      IF(D .GE. .2 .AND. D .LE. 1.) GO TO 26
      THETA=DL + .06*(4.-D)
      GO TO 22
   26 THETA=DL+ .3+.5*(1.-D)
      GO TO 22
   24 IF(D .LT. .7) GO TO 100
      THETA=DL+ .08*(4.-D)
      GO TO 22
   25 IF(D .LT. 1.) GO TO 100
      THETA=DL+ .01*(4.-D)
   22 THETA=THETA*THET
      GO TO 101
```

```
0057              100 WRITE(6,200) I,J,KMDIST,H
0058              200 FORMAT('1','**** I=',I4,' AND J =',I4,'DIST=',F10.1,
                     1 ' KM',F10.1,'METERS HEIGHT',
                     1 'THEREFORE CCRIBO DOES NOT WORK ***')
0059              101 RTHETA=THETA * .017453
0060                  XX=KMDIST * COS(RTHETA)
0061                  YY=KMDIST * SIN(RTHETA)
0062                  IF(XX .LE. .00001) XX=.00001
0063                  SIGMAY=(.10107*(XX**.917))*SIGMY
0064                  SIGMAZ=(.0524*(XX**.9))*SIGMZ
0065                  HHH=SOURCE(INC-1)* .001/ SIGMAZ
0066                  YYY=YY/SIGMAY
0067                  IF(HHH .GT. 6. .OR. YYY .GT. 6.) GO TO 15
0068                  HEXP=EXP(-.5 *HHH**2)
0069                  VEXP=EXP(-.5 *YYY**2)
0070                  ACCN=SOURCE(IND)*HEXP*VEXP/(3.1416 * WIND*SIGMAY*SIGMAZ)
                C A CONVERSION FACTOR
0071                  ACON=ACCN*.10354
0072                  BCCN(I,J)=BCCN(I,J) +ACCN
0073                  NA=NAPD(I,K)
0074                  EXPC(NA)=EXPC(NA) + ACCN*POP(J)
0075               15 CONTINUE
0076               10 CONTINUE
0077                5 CONTINUE
0078                  RETURN
0079                  END

 *OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
 *OPTIONS IN EFFECT*  NAME = CCRIBO  , LINECNT =       50
 *STATISTICS*     SOURCE STATEMENTS =        79,PROGRAM SIZE =      2464
 *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
FORTRAN IV G1  RELEASE 2.0              DATAR              DATE = 75312          15/43/25

  0001                  SUBROUTINE DATAR
                  C
                  C**********************************************************************
                  C
                  C     THIS SUBROUTINE READS IN ALL THE DATA
                  C
                  C**********************************************************************
                  C
  0002                  COMMON /A1/ NC,IC(2300)
  0003                  COMMON /COF/ IDI(11),X(11),Y(11),POP(11),AREA(11),ICC(11,2),
                       1 DIST(11,11)
  0004                  COMMON /SD/ ISN(11),NST(11),NS2(11)
  0005                  COMMON /BIG/ SOURCE(16000),MA(851,4)
  0006                  COMMON /TOTAL/ SPM(861),SSOX(861),SNOX(861),SCO(861),SHC(861)
  0007                  COMMON /CS/ CONS(860,9)
  0008                  DIMENSION NAME(16)
  0009                  DIMENSION NAM(25)
                       1 ,SI(11,5)
                  C
                  C     JUMP = 0 CAUSES TABLE TO BE INCLUDED IN OUTPUT
                  C     JUMP = 1 DELETES POLLUTION PER COUNTY TABLE
                  C
  0010                  JUMP=1
  0011                  JUMP =0
  0012                  NLN=0
  0013                  DO 5 I=1,11
  0014                  DO 5 J=1,5
  0015                5 SI(I,J)=0
  0016                  DO 8 I=1,861
  0017                  SPM(I)=0
  0018                  SSOX(I)=0
  0019                  SNOX(I)=0
  0020                  SCO(I)=0
  0021                8 SHC(I)=0
  0022                  DO 10 I=1,NC
  0023                  NUP=ISN(I)
  0024                  IF(NUP .EQ. 0) GO TO 10
  0025                  DO 15 J=1,NUP
  0026                  IDEX=NAMD(I,J)
  0027                  IND=ISLC(I,J,1)
  0028                  NLN=NLN+1
                  C
                  C     READ IN POLLUTION SOURCES
                  C
  0029                  READ  (5,100) ICT,ID(IDEX),(SOURCE(IND+II-1),II=1,6)
  0030                  SOURCE(9423) =72.
  0031                  SOURCE(9424)=5121.
  0032                  SOURCE(9425)=5557.
  0033                  SOURCE(9426)=722.
  0034                  SOURCE(9427)=70.
  0035                  IF(ID(IDEX).GT.210.AND.ID(IDEX).LE.818) ID(IDEX)=ID(IDEX)-1
  0036                  IDD=ID(IDEX)
  0037                  SPM(IDD)=SPM(IDD)+SOURCE(IND)
  0038                  SSOX(IDD)=SSOX(IDD)+SOURCE(IND+1)
  0039                  SNOX(IDD)=SNOX(IDD)+SOURCE(IND+2)
  0040                  SCO(IDD)=SCO(IDD)+SOURCE(IND+3)
  0041                  SHC(IDD)=SHC(IDD)+SOURCE(IND+4)
  0042                  DO 16 JI=1,5
  0043               16 SI(I,JI)= SI(I,JI)+SOURCE(IND+JI-1)
```

```
          IF (IC(IDEX) .GE. 821) SOURCE(IND+5)=25.
          IF (IC(IDEX) .EQ. 841) SOURCE(IND+5)=3.
          IF (IC(IDEX) .EQ. 843) SOURCE(IND+5)=3.
          IF (IC(IDEX) .GE. 846 .AND. IC(IDEX)  .LE. 850) SOURCE(IND+5)=3.
          IF (IC(IDEX) .EQ. 859) SOURCE(IND+5)=3.
          IF (IC(IDEX) .EQ. 866) SOURCE(IND+5)=3.
       15 SOURCE(IND+5)=SOURCE(IND+5) / 3.28
       10 CONTINUE
          DO 25 I=1,NC
    C
    C     READ IN CHICAGO AREA DATA
    C
          READ(5,99) IOI(I),POP(I),AREA(I),X(I),Y(I),ICO(I,1),ICO(I,2)
          WRITE(6,99)IOI(I),POP(I),AREA(I),X(I),Y(I),ICO(I,1),ICO(I,2)
       25 CONTINUE
    C
    C     TABLE ONE
    C**************************************************************
          WRITE(6,1000)
          DO 26 I=1,11
       26 WRITE(6,1001) ICO(I,1),ICO(I,2),(SI(I,J),J=1,5)
    C
    C     TABLE TWO
    C**************************************************************
          WRITE(6,1002)
          DO 27 I=1,11
       27 WRITE(6,1003) ICO(I,1),ICO(I,2),POP(I),AREA(I),X(I),Y(I)
    C
    C     TABLE FOUR
    C**************************************************************
          WRITE(6,1004)
          DO 30 I=1,819
          READ(5,103)  (MX(I,NM),NM=1,4),(NAME(II),II=1,16)
          WRITE(6,1005) I,(MX(I,NM),NM=1,4),(NAME(II),II=1,16)
       30 CONTINUE
          DO 7 J=820,860
          READ(5,104)K,(NAMP(NN),NN=1,21)
          WRITE (6,1105) K,(NAMP(NN),NN=1,21)
        7 CONTINUE
          DO 700 I=1,819
      700 READ(5,1120) (CONS(I,J),J=1,9)
          DO 701 I=821,861
      701 READ(5,1120) (CONS(I,J),J=1,9)
     1120 FORMAT(25X,8A4,A3)
    C
    C     TABLE FIVE
    C**************************************************************
          IF(JUMP .EQ. 1) RETURN
          WRITE(6,1006)
          DO 35 I=1,11
          WRITE(6,1007)  ICO(I,1),ICO(I,2)
          WRITE(6,1008)
          NLP=ISN(I)
          DO 40 J=1,NLP
          IND=ISCD(I,J,1)
          IDEX=NAMD(I,J)
          FFEET =SOURCE(IND+5) *3.28
       40 WRITE(6,1009) I,IOI(IDEX),(SOURCE(IND+II-1),II=1,5)   ,FFEET
       35 CONTINUE
       99 FORMAT(A2,6X,6F10.1,2A4)
      100 FORMAT(1X,I2,2X,I3,2X,6F10.0)
```

```
0090             103 FORMAT(5X,2(I2,1X),I3,1X,I2,1X,3(4A4,2X),4A2)
0091             104 FORMAT(6X,I3,9X,21A2)
0092            1000 FORMAT('1',15(/),19X,'COUNTY',8X,'PM',7X,'SOX',7X,'NOX',8X,
                   1 'CO',6X,'HC'/)
0093            1001 FORMAT('0',[illegible],2A4,5F10.0)
0094            1002 FORMAT('1',15(/),15X,'COUNTY',11X,'POPULATION',11X,'AREA,',6X,
                   1 'X-COOR.',5X,'Y-COOR.'/51X,'SQ. MILES',5X,'MILES',7X,'MILES'/)
0095            1003 FORMAT('/',12X,2A4,10X,F10.0,8X,F10.0,2F12.0)
0096            1004 FORMAT('1',10(/),2X,'SOURCE',3X,'SOURCE',38X,'SCC CATEGORY'/2X,
                   1 'NUMBER',3X,'CLASSIFICATION',30X,'NAME'/11X,'CODE (SCC)'//)
0097            1005 FORMAT(' ',4X,I3,6X,I1,1X,I2,1X,I3,1X,I2,4X,3(4A4,2X),4A2)
0098            1006 FORMAT('1',7(/))
0099            1007 FORMAT('-',27X,'EMISSION SOURCES IN ',2A4,' COUNTY'//)
0100            1008 FORMAT(' ',9X,'COUNTY #  SOURCE #',6X,'PM',5X,'SOX',5X,'NOX',6X,
                   1 'CO',6X,'HC',2X,'HEIGHT, FT.'/)
0101            1009 FORMAT(' ',13X,I3,7X,I3,5F8.0,F13.0)
0102            1100 FORMAT(1X,I2,2X,I3,2X,6F10.0,I10)
0103            1105 FORMAT(' ',4X,I3,21X,21A2)
0104            1110 FORMAT(I5,5F12.2)
0105                 RETURN
0106                 END

  *OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
  *OPTIONS IN EFFECT*  NAME = DATAR   , LINECNT =       50
  *STATISTICS*     SOURCE STATEMENTS =       106,PROGRAM SIZE =      4336
  *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
FORTRAN IV G1  RELEASE 2.0            DISTAN            DATE = 75312         15/43/25
 0001                SUBROUTINE DISTAN
 0002                COMMON /OPT/ JOHOP,DSC,IF(5),FF(5),WIND,THET,SIGMY,SIGMZ
                    1,JOB
 0003                COMMON /SD/ ISN(11),NST(11),NS2(11)
 0004                COMMON /A1/ NC,IC(2300)
 0005                COMMON /LEF/ TOT(11),X(11),Y(11),POP(11),AREA(11),ICO(11,2),
                    1 DIST(11,11)
 0006                DO 5 I=1,NC
 0007                J=I+1
 0008                IF(J .GT. NC) GO TO 15
 0009             10 DIST(I,J)=ABS(SQRT((ABS(X(I)-X(J)))**2. +(ABS(Y(I)-Y(J)))**2.))
 0010                DIST(J,I)=DIST(I,J)
 0011                J=J+1
 0012                IF(J .GT. NC) GO TO 15
 0013                GO TO 10
 0014             15 DIST(I,I)=DSC*(ABS(SQRT(AREA(I)/3.1416)) *.259 -.045)
 0015              5 CONTINUE
               C
               C     TABLE THREE
               C*****************************************************************
 0016                  WRITE (6,999)
 0017                WRITE(6,1000) (ICO(I,1),I=1,11)
 0018                DO 20 I=1,11
 0019             20 WRITE(6,1001) ICO(I,1),ICO(I,2),(DIST(I,J),J=1,11)
 0020            999 FORMAT ('1',/////////, 5X, 'DISTANCES BETWEEN COUNTY CENTERS, IN MI
                    1LES  (INTRACOUNTY DISTANCES ARE CALCULATED FROM AR EQN WITH M=0')
 0021           1000 FORMAT(' ', 3(/),17X,11(A4,3X)//)
 0022           1001 FORMAT(' ',5X,2A4,11F7.1///)
 0023                RETURN
 0024                END

*OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
*OPTIONS IN EFFECT*  NAME = DISTAN  , LINECNT =       60
*STATISTICS*     SOURCE STATEMENTS =       24,PROGRAM SIZE =      1120
*STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
FORTRAN IV G1  RELEASE 2.0          ISOD            DATE = 75312          15/43/25
  0001                 FUNCTION ISOD(I,M,N)
                 C
                 C*****************************************************************
                 C
                 C     THE FUNCTION ISOD RETURNS AN INTEGER NUMBER WHICH IS THE ELEMENT
                 C     ADDRESS OF THE 1 - DIMENSIONAL ARRAY SOURCE CORRESPONDING TO (I,M,N)
                 C
                 C     I -  CORRESPONDING TO THE COUNTY NUMBER
                 C     M -  CORRESPONDS TO POLLUTANT INDEX
                 C     N -  CORRESPONDS TO SOURCE INSIDE COUNTY
                 C
                 C*****************************************************************
                 C
  0002                 COMMON /SC/ ISN(11),KST(11),NS2(11)
  0003                 ISOD=KST(I) + (M-1)*7 + (N-1)
  0004                 RETURN
  0005                 END

 *OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
 *OPTIONS IN EFFECT*  NAME = ISOD    , LINECNT =       60
 *STATISTICS*    SOURCE STATEMENTS =        5,PROGRAM SIZE =       300
 *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
FORTRAN IV G1  RELEASE 2.0              MASSE               DATE = 75312          15/43/25
 0001                  SUBROUTINE MASSE
 0002                  COMMON /AI/ NC,ID(2300)
 0003                  COMMON /SO/ ISN(11),NST(11),NS2(11)
 0004                  COMMON /B15/ SOURCE(16000),NA(801,4)
 0005                  COMMON /CPT/ JOOOP,ESC,TF(5),FF(5),WIND,THET,SIGMY,SIGMZ
                      1,JOR
 0006                  COMMON /VAL/ EMSS(2300),PIND(2300),PCPEXF(2300)
 0007                  DIMENSION SUMN(11),SUMK(2300)
 0008                  DO 5 I=1,11
 0009                5 SUMN(I)=0
 0010                  GTOT=0
 0011                  DO 10 I=1,11
 0012                  IS=ISN(I)
 0013                  IF(IS .EQ. 0) GO TO 10
 0014                  DO 15 J=1,IS
 0015                  IND=ISLD(I,J,1)
 0016                  IDI=NAMD(I,J)
 0017                  SUMK(IDI)=SOURCE(IND)+SOURCE(IND+1)+SOURCE(IND+2)+SOURCE(IND+3)
                      1  + SOURCE(IND+4)
 0018               15 SUMN(I)=SUMN(I)+SUMK(IDI)
 0019               10 GTOT=GTOT + SUMN(I)
 0020                  DO 20 I=1,11
 0021                  IS=ISN(I)
 0022                  IF(IS .EQ. 0) GO TO 20
 0023                  DO 25 J=1,IS
 0024                  IDI=NAMD(I,J)
 0025               25 EMSS(IDI)=SUMK(IDI)/GTOT*100.
 0026               20 CONTINUE
 0027                  RETURN
 0028                  END

 *OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
 *OPTIONS IN EFFECT*  NAME = MASSE  , LINECNT =       60
 *STATISTICS*     SOURCE STATEMENTS =        28,PROGRAM SIZE =     1008
 *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
FORTRAN IV G1  RELEASE 2.0            NAMD                DATE = 75312          15/43/25
 0001                        FUNCTION NAMD(I,J)
                       C
                       C*****************************************************************
                       C
                       C     THE FUNCTION NAMD RETURNS AN INTEGER NUMBER WHICH IS THE ELEMENT
                       C     ADDRESS OF A 1 - DIMENSIONAL ARRAY CORRESPONDING TO (I,J)
                       C
                       C     I -  COUNTY NUMBER
                       C     J -  SOURCE INSIDE THAT COUNTY
                       C
                       C*****************************************************************
                       C
 0002                        COMMON /SD/ ISN(11),NST(11),NS2(11)
 0003                        NAMD=NS2(I) + (J-1)
 0004                        RETURN
 0005                        END

  *OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
  *OPTIONS IN EFFECT*  NAME = NAMD    , LINECNT =        60
  *STATISTICS*    SOURCE STATEMENTS =        5,PROGRAM SIZE =       346
  *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
FORTRAN IV G1  RELEASE 2.0            PINDEX              DATE = 75312          15/43/25

                      SUBROUTINE PINDEX
                      COMMON /XI/ NC,IC(2300)
                      COMMON /VAL/ EMSS(2300),PIND(2300),PGMEXP(2300)
                      COMMON /LLF/ ISI(11),X(11),Y(11),FCP(11),AREA(11),ICG(11,2),
                    1 DIST(11,11)
                      COMMON /SD/ ISN(11),NS1(11),NS2(11)
                      COMMON /PINDE/ PSOUCE(861),PPM(861),PSOX(861),PNOX(861),PCO(861),
                    1 PHC(861)
                      COMMON /OPT/ JOBOF,DSC,TF(5),FF(5),WIND,THET,SIGMY,SIGMZ
                    1,JOB
                      COMMON /EIG/ SOURCE(16000),MX(861,4)
                      DIMENSION SPIN(11)
                      GT=0
                      DO 1 I=1,NC
                    1 SPIN(I)=0
                      DO 5 I=1,861
                      PPM(I)=0.
                      PSOX(I)=0.
                      PNOX(I)=0.
                      PCO(I)=0.
                      PHC(I)=0.
                    5 PSOUCE(I)=0
                      DO 10 I=1,NC
                      IS=ISN(I)
                      IF(IS .EQ. 0) GO TO 10
                      DO 15 J=1,IS
                      IDEX=ISOD(I,J,1)
                      IND=NAND(I,J)
                      IDD=IC(IND)
                      TPM=SOURCE(IDEX)*TF(1)
                      TSOX=SOURCE(IDEX+1)*TF(2)
                      TNOX=SOURCE(IDEX+2)*TF(3)
                      TCO=SOURCE(IDEX+3)*TF(4)
                      THC=SOURCE(IDEX+4)*TF(5)
                      SOURCE(IDEX+6)=TPM+TSOX+TNOX+TCO+THC
                      PPM(IDD)=TPM + PPM(IDD)
                      PSOX(IDD)=TSOX + PSOX(IDD)
                      PNOX(IDD)= TNOX + PNOX(IDD)
                      PCO(IDD)=TCO + PCO(IDD)
                      PHC(IDD)=THC + PHC(IDD)
                   15 SPIN(I)=SPIN(I)+SOURCE(IDEX+6)
                      GT=GT+SPIN(I)
                   10 CONTINUE
                      DO 20 I=1, NC
                      IS=ISN(I)
                      IF(IS .EQ. 0) GO TO 20
                      DO 25 J=1,IS
                      IDEX=NAND(I,J)
                      IND=ISOD(I,J,7)
                      PIND(IDEX)=SOURCE(IND)/GT*100.
                      IDD=IC(IDEX)
                   25 PSOUCE(IDD)=PSOUCE(IDD)+PIND(IDEX)
                   20 CONTINUE
                      DO 26 IDD=1,ICOT
                      PPM(IDD)=(PPM(IDD)*100.)/GT
                      PSOX(IDD)=(PSOX(IDD)*100.)/GT
                      PNOX(IDD)=(PNOX(IDD)*100.)/GT
                      PCO(IDD)=(PCO(IDD)*100.)/GT
                      PHC(IDD)=(PHC(IDD)*100.)/GT
```

```
0057              20 CONTINUE
0058                 RETURN
0059                 END

 *OPTIONS IN EFFECT*  NOTERM.ID.EBCDIC.SOURCE.NOLIST.NODECK.LOAD.NOMAP.NOTEST
 *OPTIONS IN EFFECT*  NAME = PINDEX  . LINECNT =       50
 *STATISTICS*    SOURCE STATEMENTS =        59.PROGRAM SIZE =      1414
 *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
                SUBROUTINE RITEA
                COMMON /A1/ NC,ID(2300)
                COMMON /BIG/ SOURCE(16000),NX(861,4)
                COMMON /SD/ ISN(11),NST(11),NS2(11)
                COMMON /LEF/ ICI(11),X(11),Y(11),FOP(11),AREA(11),ICO(11,2),
               1 DIST(11,11)
                COMMON /CS/ CONS(860,9)
                COMMON /PINDE/ PSOUCE(861),PPM(861),PSOX(861),PNOX(861),PCO(861),
               1 PHC(861)
                COMMON /TOTAL/ SPM(861),SSOX(861),SNOX(861),SCO(861),SHC(861)
                COMMON /IMF/ UCON(11,11),CCON(11),EXPC(2300),EXPA(11)
                COMMON /OPT/ JOBOP,DSC,IF(5),FF(5),WIND,THET,SIGMY,SIGMZ
               1,JOB
                COMMON /VAL/ EMSS(2300),FINC(2300),FOPEXP(2300)
                DIMENSION ADUP(1000),ADUP1(1000),ADUP2(1000)
               1  ,SORT(1000),MSORT(1000)
               1  ,ADD(1000),SPC(5)
                INTEGER TOTC,TTC  ,SSK1
                AA=1.
                BB=.1
                CC=.01
                DD=.001
                SOD1=0
                SOD2=0
                SOD3=0
                SOD4=0
                SOD5=0
                SOD6=0
C   WHICH ONE
                IF(JOB .EQ. 1) GO TO 100
                DO 10 I=1,1000
                ADUP1(I)=0
                ADUP2(I)=0
           10   ADUP(I)=0
                DO 49 I=821,861
                DO 49 KR=1,4
     49         NX(I,KR)=0
                DO 15 I=1,NC
                IS=ISN(I)
                IF(IS .EQ. 0) GO TO 15
                DO 20 J=1,IS
                IND=NAMUT(I,J)
                K1=ID(IND)
                ADUP(K1)=ADUP(K1)+EMSS(IND)
                ADUP1(K1)=ADUP1(K1)+FINC(IND)
           20   ADUP2(K1)=ADUP2(K1)+FOPEXP(IND)
           15   CONTINUE
C
C       INDIVIDUAL SOURCE TABLE
C*******************************************************************
                WRITE (6,4002)
         4002   FORMAT ('1',11(/),12X, 'TABLE XI.  EMISSIONS AND RESULTS OF MASS I
               1NDEX, FINDEX AND FOPEX FOR EACH OF THE',/,23X,'SOURCE-CATEGORIES I
               2N THE CHICAGO AQCR',///)
         3001   WRITE(6,4000)
         4000   FORMAT (' ',13X,'SOURCE                             TOTAL          PM         SO2
               1         NOX            CO           HC',/,12X,'CATEGORY',//)
                SSK1=5
                DO 22 I=2,861
```

```
      DIVID=SPM(I)+SSOX(I)+SNOX(I)+SCO(I)+SHC(I)
      IF(DIVID .EQ. 0 .AND. ADUP(I) .EQ. 0) GO TO 22
      RATIOP=SPM(I)/DIVID
      RATIOS=SSOX(I)/DIVID
      RATION=SNOX(I)/DIVIC
      RATICC=SCO(I)/DIVID
      RATIOH=SHC(I)/DIVID
      EPM=RATIOP*ADUP(I)
      ESOX=RATIOS*ADUP(I)
      ENOX=RATICN*ADUP(I)
      ECO=RATICC*ADUP(I)
      EHC=RATICH*ADUP(I)
      IF(SSKI .NE. 12) GO TO 171
      SSKI=4
      WRITE (6,4003)
 4003 FORMAT ('1',10(/),12X,'TABLE XI.  CONTINUED. ',//)
      WRITE (6,4000)
  171 SSKI=SSKI+1
      WRITE(6,5000) I,DIVIC,SPM(I),SSOX(I),SNOX(I),SCO(I),SHC(I),
     1 ADUP(I),EPM,ESOX,ENOX,ECO,EHC,PSOUCE(I),PPM(I),PSOX(I),PNOX(I),
     1 PCO(I),PHC(I),ADUP2(I)
   22 CONTINUE
 5000 FORMAT (' ',16X,13,2X,'EMISSIONS ',F11.0,5F10.0/22X,'MASS INDEX ',
     1 6F10.2/22X,'PINDEX      ',6F10.2/22X,'POPEX       ',F10.2/)
      WRITE (6,56)
56    FORMAT (1H1,      ' NUM  MASS INDEX  PINDEX      PI/M       POPEX
     1  PO/PI')
      DO 300 I=1,861
      IF (ADUP(I) .LE. 0.) GO TO 300
      PPM=ADUP2(I)/ADUP1(I)
      PINMM=ADUP1(I) /ADUP(I)
      WRITE (6,1006) I,ADUP(I),ADUP1(I),PINMM ,ADUP2(I),PPM
 1006 FORMAT ('0',5X,I5,5F10.3)
300   CONTINUE
      WRITE(6,1012)
 1012 FORMAT('1',4X,'SOURCE',10X,'ADUP2',5X,'DIFFERENCES'//)
      DO 31 I=1,1000
      IF(ADUP2(I) .EQ. 0) GO TO 31
      DIF4=ADUP(I)-ADUP2(I)
      DIF5=ADUP1(I)-ADUP2(I)
      DIF6=ADUP(I)-ADUP1(I)
      DIF1=ABS(DIF4)/ADUP2(I)*100.
      DIF2=ABS(DIF5)/ADUP2(I)*100.
      DIF3=ABS(DIF6)/ADUP1(I)*100.
      SUD1=SUD1+DIF1
      SUD2=SUD2+DIF2
      SUD3=SUD3+DIF3
      SUD4=SUD4 +ABS(DIF4)
      SUD5=SUD5 +ABS(DIF5)
      SUD6=SUD6 +ABS(DIF6)
      WRITE(6,1010) I,ADUP2(I),DIF1,DIF4,DIF2,DIF5,DIF3,DIF6
 1010 FORMAT(' ',5X,I3,5X,F10.3,3(F10.2,1X,F10.2,3X)       )
   31 CONTINUE
      WRITE(6,1013)
 1013 FORMAT('1',5X,'THE SUM OF DIF 1-6'//)
      WRITE(6,1011) SUD1,SUD2,SUD3,SUD4,SUD5,SUD6
 1011 FORMAT(' ',5X,6F10.2)
      GO TO 99
98    NNNNN=3
      IF(JOB .EQ. 3) GO TO 200
      IF( JOB .EQ. 2) GO TO 200
```

```
          WRITE (6.56)
          DO 35 I=1.1000
       35 SORT(I)=ADUP(I)
          CALL SCRTIT(SCRT.MSORT.1000)
          DO 40 I=1.1000
          II=MSCRT(I)
          IF(ADUP(II) .EQ. 0) GO TO 40
          WRITE(6.1005) II.(MX(II.KM).KM=1.4).
        1  ADUP(II).ADUP1(II).ADUP2(II)
     1005 FORMAT('0'.5X.         I5.5X.4(2X.I3.2X)   .3F10.2.3I5.2F10.2)
       40 CONTINUE
          WRITE (6.56)
          DO 45 I=1.1000
       45 SORT(I)=ADUP1(I)
          CALL SCRTIT(SORT.MSORT.1000)
          DO 50 I=1.1000
          II=MSCRT(I)
          IF(ADUP1(II) .EQ. 0) GO TO 50
          WRITE(6.1005) II.(MX(II.KM).KM=1.4).
        1  ADUP(II).ADUP1(II).ADUP2(II)
       50 CONTINUE
       99 KKKKK=3
C
C         TABLE SIX
C******<**********************************************************
     5001 CONTINUE
          SSK1=1
          WRITE (6.1014)
     1014 FORMAT ('1'.11(/). 5X.  'TABLE XII. CHIACGO AQCR SOURCE-CATEGORIES
        1 IN THE DECREASING ORDER OF POPEX.'.//)
          WRITE(6.1015)
          DO 52 I=1.5
       52 SPO(I)=0
          DO 51 I=1.1000
          SCRT(I)=ADUP2(I)
       51 CONTINUE
          CALL SCRTIT(SCRT.MSORT.1000)
          DO 55 I=1.1000
          II=MSCRT(I)
          IF(ADUP2(II) .EQ. 0) GO TO 55
          A =ADUP(II)
          A1=ADUP1(II)
          A2=ADUP2(II)
          IF (A .GE. AA)K=1
          IF (A1.GE. AA)K1=1
          IF (A2.GE. AA)K2=1
          IF(A .GE.  BB .AND. A .LT. AA)  K =2
          IF(A1.GE.  BB .AND. A1.LT. AA)  K1=2
          IF(A2.GE.  BB .ANC. A2.LT. AA)  K2=2
          IF (A  .GE. CC  .AND. A  .LT.BB)  K=3
          IF (A1 .GE. CC  .AND. A1 .LT.BB)  K1=3
          IF (A2 .GE. CC  .AND. A2 .LT.BB)  K2=3
          IF (A .GE. DD .AND. A  .LT. CC)  K=4
          IF (A1.GE. DD .AND. A1 .LT. CC) K1=4
          IF (A2.GE. DD .AND. A2 .LT. CC) K2=4
          IF (A  .LT. DD )  K =5
          IF (A1 .LT. DD )  K1=5
          IF (A2 .LT. DD )  K2=5
          DO 201 KCOUNT=1.5
      201 IF(K2 .EQ. KCOUNT) SPE(KCOUNT)=SPE(KCOUNT)+A2
          PINMR=ADUP1(II)/ADUP(II)
      PWR=ADUP2(I)  / ADUE(II)
      IF (SSKI .NE. 5 ) GO TO 211
      SSKI=1
      WRITE (6.1021)
 1021 FORMAT ('0'. /.9X.'I. MI-MASS INDEX. PI-FINDEX. PO-PCPEX')
      WRITE (6.1020)
 1020 FORMAT ('1'.11(/). 8X.'TABLE XII.  CONTINUED.'//)
      WRITE (6.1015)
  211 SSKI= SSKI+1
      WRITE(6.1007) II.(CDAS(II.J).J=1.5).ADUP(II).ADUP1(II).
     1 ADUP2(II).K.K1.K2
   55 CONTINUE
      WRITE (6.1021)
      WRITE(6.203) SPC
  203 FORMAT('1'.5X.'PERCENT CONTRIBUTION BY EACH RANK'.5F10.3)
      JJJ=1
      RETURN
  100 DO 101 I=1.1000
  101 ADD(I)=0
      DO 110 I=1.NC
      IS=ISN(I)
      IF(IS .EQ. 0) GO TO 110
      DO 115 J=1.IS
      IND=KARD(I.J)
      K1=IC(IND)
  115 ADD(K1)=ADD(K1)+PCPEXP(IND)
  110 CONTINUE
      SAD=0
      SDI=0
      TTC=0
      TOTC=0
      DO 120 I=1.1000
      IF(ADUP2(I) .EQ. 0.) GO TO 120
      DI=ADD(I)-ADUP2(I)
      DIF=DI/ADUP2(I)*100.
      DIF=ABS(DIF)
      SAD=SAD+DIF
      SDI=SDI+ABS(DI)
      A=ADUP2(I)
      A1=ADD(I)
      IF(A .GE.AA) K=1
      IF(A1 .GE. AA) K1=1
      IF(A .GE. BB .AND. A .LT. AA) K=2
      IF(A1 .GE. BB .AND. A1 .LT. AA)  K1=2
      IF(A .GE. CC .AND. A .LT. BB) K=3
      IF(A1 .GE. CC .AND. A1 .LT.BB) K1=3
       IF(A .GE. DD .AND. A .LT. CC) K=4
      IF(A1 .GE. DD .AND. A1 .LT. CC) K1=4
      IF(A .LT. DD)K=5
      IF(A1 .LT. DD) K1=5
      IF(K .EQ. 1 .AND. K1 .EQ. 2) TTC=TTC+1
      IF(K1 .EQ. 1 .AND. K .EQ. 2) TTC=TTC+1
      TOTC=TOTC + IABS(K-K1)
      WRITE(6.500) I.ADUP2(I).DI.DIF.ADD(I).K.K1
  500 FORMAT(' '.5X.I5.F12.5.2F10.2.F12.5.2I10)
  120 CONTINUE
      NAD=0
      DO 60 I=1.1000
      IF(ADD(I) .NE. 0) NAD=NAD+1
   60 CONTINUE
      SI=SAD/NAD
```

```
0220                   S2=S1/NAD
0221                   WRITE (6,510) JGROUP,S1,S2,TOTC,TTC
0222             510   FORMAT ('1',        5X,'JGROUP=', I3,'        AVG PCT DIFF=',F10.3,
                      1'       AVG DIFF='        ,F10.4,'      CHNG IN RANKINGS=',I4,
                      2 CHNG RNK 1-2 OR 2-1=',I3)
0223            1007 FORMAT (' ',13X,I3,2X,8A4,A3,3G10.2,3X,3I5)
0224            1015 FORMAT ('0',84X,'1',/,11X,  'SOURCE  SOURCE-CATEGORY NAME',16X,
                      1'PERCENT CONTRIBUTION TO INDICES',6X,'RANKINGS',/, 9X,'CATEGORY',
                      240X,
                      3'MI          PI          PO             MI   PI   PO'/)
0225             200 JOB=1
0226                   RETURN
0227                   END

 *OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
 *OPTIONS IN EFFECT*  NAME = RITEA    , LINECNT =        50
 *STATISTICS*     SOURCE STATEMENTS =        227,PROGRAM SIZE =     31544
 *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
FORTRAN IV G1  RELEASE 2.0            SENSE            DATE = 75312          15/43/25

 0001                   SUBROUTINE SENSE
                  C
                  C**********************************************************************
                  C
                  C     THIS SUBROUTINE DETERMINES HOW SENSITIVE THE MODEL IS TO
                  C     VARIABLE CHANGES
                  C
                  C**********************************************************************
                  C
 0002                   COMMON /SO/ ISKY(11),NST(11),NS2(11)
 0003                   COMMON /BIG/ SOURCE(16000),MX(861,4)
 0004                   COMMON /A1/ NC,ID(2300)
 0005                   COMMON /CPT/ JOBOP,DSC,TF(5),FF(5),WIND,THET,SIGMY,SIGMZ
                       1,JJJ
 0006                   CHECK=0
 0007                   GO TO (1,2,3,3,3,3,3,4,5,6,7),JOBOP
                  C
                  C     CHECKS DSC SENSITIVITY
                  C
 0008                 1 DSC=DSC*1.5
 0009                   JJ=1
 0010                   GO TO 10
 0011               100 DSC=(1/3.)*DSC
 0012                   GO TO 10
                  C
                  C     CHECKS TF(5) SENSITIVITY
                  C
 0013                 2 TF(5) = FF(4)/25.
 0014                   JJ=2
 0015                   GO TO 10
 0016               101 TF(1)=0
 0017                   TF(2)=1
 0018                   GO TO 10
                  C
                  C     CHECKS JOBOP 3 - 6
                  C
 0019                 3 KK=JOBOP-2
 0020                   IF(KK .EQ. 4) GO TO 50
 0021                   FF(KK)=1.5*FF(KK)
 0022                   TF(KK)=FF(4)/FF(KK)
 0023                   JJ=3
 0024                   GO TO 10
                  C
                  C     CHECKS JOBOP 7
                  C
 0025                50 JJ=3
 0026                   FF(4)=1.5*FF(4)
 0027                   TF(4)=2900./FF(4)
 0028                   GO TO 10
 0029               102 FF(KK)=(1/3.)*FF(KK)
 0030                   IF(KK .EQ. 4) GO TO 51
 0031                   TF(KK)=FF(4)/FF(KK)
 0032                   GO TO 10
 0033                51 TF(4)=2900./FF(4)
 0034                   GO TO 10
                  C
                  C     THETA SENSITIVITY
                  C
 0035                 4 THET=1.5
```

```
      JJ=4
      GO TO 10
  103 THET=.5
      GO TO 10
C
C     SIGMA Y SENSITIVITY
C
    5 SIGMY=1.5
      JJ=5
      GO TO 10
  104 SIGMY=.5
      GO TO 10
C
C     SIGMA Z SENSITIVITY
C
    6 SIGMZ=1.5
      JJ=6
      GO TO 10
  105 SIGMZ=.5
      GO TO 10
C
C     POLLUTION HEIGHT SENSITIVITY
C
    7 DO 21 I=1,11
      IS=ISN(I)
      IF(IS .EQ. 0) GO TO 21
      DO 25 J=1,15
      IND=ISCD(I,J,6)
   25 SOURCE(IND)=SOURCE(IND) *1.5
   21 CONTINUE
       JJ=7
      GO TO 10
  106 DO 30 I=1,11
      IS=ISN(I)
      IF(IS .EQ. 0) GO TO 30
      DO 35 J=1,15
      IDEX=NAMD(I,J)
      IND=ISCD(I,J,6)
      IF(IC(IDEX) .GE. 821) GO TO 31
      SOURCE(IND)=SOURCE(IND)* 2/3.
      GO TO 35
   31 SOURCE(IND)=SOURCE(IND) *1/3.
   35 CONTINUE
   30 CONTINUE
   10 CALL DISTAN
      CALL PINDEX
      CALL MASSE
      CALL CURIDO
      CALL SUMDIS
      CALL RITEA
      IF(CHECK .EQ. 1) GO TO 20
      CHECK=1
      GO TO (100,101,102,103,104,105,106),JJ
   20 RETURN
      END

*OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
*OPTIONS IN EFFECT*  NAME = SENSE    , LINECNT =       50
*STATISTICS*     SOURCE STATEMENTS =       81,PROGRAM SIZE =      1734
*STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
FORTRAN IV G1  RELEASE 2.0              SORTIT             DATE = 75312           15/43/25
 0001               SUBROUTINE SORTIT(SORT,MSORT,NI)                                       00000010
               C******************************************************************** 00000020
               C                                                                        00000030
               C       SORTING SUBROUTINE
               C
               C       THIS IS A DECREASING ORDER BUBBLE SORT
               C       IT LEAVES THE ARRAY TO BE SORTED IN ITS ORIGINAL ORDER
               C       IT LEAVES THE ARRAY INDICIES SORTED IN MSORT
               C                                                                        00000040
               C******************************************************************** 00000050
 0002                   DIMENSION SORT(NI),MSORT(NI)                                    00000060
 0003                   DO 10 I=1,NI                                                    00000070
 0004                10 MSORT(I)=I                                                      00000080
 0005                   DO 15 I=1,NI                                                    00000090
 0006                   IF(I .LT. NI) II=I+1                                            00000100
 0007                   DO 20 N=II,NI                                                   00000110
 0008                   IF(SORT(I) .GT. SORT(N)) GO TO 20                               00000120
 0009                   SO=SORT(I)                                                      00000130
 0010                   SORT(I)=SORT(N)                                                 00000140
 0011                   SORT(N)=SO                                                      00000150
 0012                   MX=MSORT(I)                                                     00000160
 0013                   MSORT(I)=MSORT(N)                                               00000170
 0014                   MSORT(N)=MX                                                     00000180
 0015                20 CONTINUE                                                        00000190
 0016                15 CONTINUE                                                        00000200
 0017                   RETURN                                                          00000210
 0018                   END                                                             00000220

  *OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
  *OPTIONS IN EFFECT*  NAME = SORTIT  , LINECNT =       60
  *STATISTICS*     SOURCE STATEMENTS =        18,PROGRAM SIZE =       624
  *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
FORTRAN IV G1  RELEASE 2.0             SUMDIS            DATE = 75312         15/43/25

  0001                   SUBROUTINE SUMDIS
  0002                   COMMON /A1/ NC,IC(2300)
  0003                   COMMON /IMP/ BCON(11,11),CCON(11),EXPC(2300),EXPA(11)
  0004                   COMMON /LEF/ IDI(11),X(11),Y(11),POP(11),AREA(11),ICO(11,2),
                        1 DIST(11,11)
  0005                   COMMON /SD/ ISN(11),NST(11),NS2(11)
  0006                   COMMON /OPT/ JOBOP,DSC,TF(5),FF(5),WIND,THET,SIGMY,SIGMZ
                        1,JOS
  0007                   COMMON /VAL/ EMSS(2300),PIND(2300),PCPEXP(2300)
  0008                   SUMEXP=0
  0009                   DO 10 J=1,NC
  0010                   DO 15 I=1,NC
  0011                15 CCON(J)=CCON(J) + BCON(I,J)
  0012                   EXPA(J)=CCON(J)*PCP(J)
  0013                10 SUMEXP=SUMEXP + EXPA(J)
  0014                   DO 20 I=1,NC
  0015                   IS=ISN(I)
  0016                   IF(IS .EQ. 0) GO TO 20
  0017                   DO 25 K=1,IS
  0018                   NA=NAMC(I,K)
  0019                25 POPEXP(NA)=(EXPC(NA)/SUMEXP) * 100.
  0020                20 CONTINUE
  0021                   WRITE (6,60)
  0022            60     FORMAT ('1',10(/),      5X,'PINDEX CORRECTED POLLUTION CONCENTRATI
                        1ON MATRIX',////)
  0023                   WRITE (6,50)  (ICO(I,1),I=1,NC)
  0024                50 FORMAT(11(5X,A4),'   TOTAL FOR COUNTY')
  0025                   DO 30 J=1,NC
  0026               30  WRITE (6,40) (BCON(I,J),I=1,NC),CCON(J),ICO(J,1)
  0027                40 FORMAT(2X,11E9.2,F10.0,1X,A4)
  0028                   RETURN
  0029                   END

   *OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
   *OPTIONS IN EFFECT*  NAME = SUMDIS   , LINECNT =        50
   *STATISTICS*    SOURCE STATEMENTS =        29,PROGRAM SIZE =     1060
   *STATISTICS*  NO DIAGNOSTICS GENERATED

   *STATISTICS*  NO DIAGNOSTICS THIS STEP
```

APPENDIX C

LISTING OF THE SOURCE-CATEGORY NUMBERS AND THE SOURCE CLASSIFICATION CODES (SCC)

NO.	SCC	SOURCE CLASSIFICATION CODE (SCC) CATEGORY NAMES
1	1 01 001 01	EXTCOMB BOILER /ELECTRIC GENERATN/ANTHRACITE COAL /G100MMBTU PULVIZD /TONS BURNED
2	1 01 001 02	EXTCOMB BOILER /ELECTRIC GENERATN/ANTHRACITE COAL /G100MMBTU STOKER /TONS BURNED
3	1 01 001 03	EXTCOMB BOILER /ELECTRIC GENERATN/ANTHRACITE COAL / 10-100MMBTU PULVD /TONS BURNED
4	1 01 001 04	EXTCOMB BOILER /ELECTRIC GENERATN/ANTHRACITE COAL / 10-100MMBTU STOKR /TONS BURNED
5	1 01 001 05	EXTCOMB BOILER /ELECTRIC GENERATN/ANTHRACITE COAL /L10MMBTU PULVIZED /TONS BURNED
6	1 01 001 06	EXTCOMB BOILER /ELECTRIC GENERATN/ANTHRACITE COAL /L10MMBTU STOKER /TONS BURNED
7	1 01 001 99	EXTCOMB BOILER /ELECTRIC GENERATN/ANTHRACITE COAL / OTHER/NOT CLASIFD /TONS BURNED
8	1 01 002 01	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL /G100MMBTU PULVWET /TONS BURNED
9	1 01 002 02	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL /G100MMBTU PULVDRY /TONS BURNED
10	1 01 002 03	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL /G100MMBTU CYCLONE /TONS BURNED
11	1 01 002 04	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL /G100MMBTU SPDSTKR /TONS BURNED
12	1 01 002 05	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL /G100MMBTU/HR OFSK /TONS BURNED
13	1 01 002 06	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL / 10-100MMBTU PULWT /TONS BURNED
14	1 01 002 07	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL / 10-100MMBTU PULDY /TONS BURNED
15	1 01 002 08	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL / 10-100MMBTU OFSTK /TONS BURNED
16	1 01 002 09	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL / 10-100MMBTU UFSTK /TONS BURNED
17	1 01 002 10	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL /L10MMBTU OFSTOKER /TONS BURNED
18	1 01 002 11	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL /L10MMBTU UFSTOKER /TONS BURNED
19	1 01 002 12	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL /L10MMBTU PULV-DRY /TONS BURNED
20	1 01 002 99	EXTCOMB BOILER /ELECTRIC GENERATN/BITUMINOUS COAL / OTHER/NOT CLASIFD /TONS BURNED
21	1 01 003 01	EXTCOMB BOILER /ELECTRIC GENERATN/LIGNITE /G100MMBTU PULVWET /TONS BURNED
22	1 01 003 02	EXTCOMB BOILER /ELECTRIC GENERATN/LIGNITE /G100MMBTU PULVDRY /TONS BURNED
23	1 01 003 03	EXTCOMB BOILER /ELECTRIC GENERATN/LIGNITE /G100MMBTU CYCLONE /TONS BURNED
24	1 01 003 04	EXTCOMB BOILER /ELECTRIC GENERATN/LIGNITE /G100MMBTU OF STKR /TONS BURNED
25	1 01 003 05	EXTCOMB BOILER /ELECTRIC GENERATN/LIGNITE /G100MMBTU UF STKR /TONS BURNED
26	1 01 003 06	EXTCOMB BOILER /ELECTRIC GENERATN/LIGNITE /G100MMBTU SPDSTKR /TONS BURNED
27	1 01 003 07	EXTCOMB BOILER /ELECTRIC GENERATN/LIGNITE / 10-100MMBTU DYPUL /TONS BURNED
28	1 01 003 08	EXTCOMB BOILER /ELECTRIC GENERATN/LIGNITE / 10-100MMBTU WTPUL /TONS BURNED
29	1 01 003 09	EXTCOMB BOILER /ELECTRIC GENERATN/LIGNITE / 10-100MMBTU OFSTK /TONS BURNED
30	1 01 003 10	EXTCOMB BOILER /ELECTRIC GENERATN/LIGNITE / 10-100MMBTU UFSTK /TONS BURNED

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31   1 01 003 11 EXTCOMB BOILER   /ELECTRIC GENERATN/LIGNITE            / 10-100MMBTUSPRDSTK /TONS BURNED
32   1 01 003 12 EXTCOMB BOILER   /ELECTRIC GENERATN/LIGNITE            /L10MMBTU PULV DRY   /TONS BURNED
33   1 01 003 13 EXTCOMB BOILER   /ELECTRIC GENERATN/LIGNITE            /L10MMBTU OF STOKR   /TONS BURNED
34   1 01 003 14 EXTCOMB BOILER   /ELECTRIC GENERATN/LIGNITE            /L10MMBTU UF STOKR   /TONS BURNED
35   1 01 003 15 EXTCOMB BOILER   /ELECTRIC GENERATN/LIGNITE            /L10MMBTU SPDSTOKR   /TONS BURNED
36   1 01 004 01 EXTCOMB BOILER   /ELECTRIC GENERATN/RESIDUAL OIL       /G100MMBTU/HR GENL   /1000GALLONS BURNED
37   1 01 004 02 EXTCOMB BOILER   /ELECTRIC GENERATN/RESIDUAL OIL       / 10-100MMBTU/HRGNL  /1000GALLONS BURNED
38   1 01 004 03 EXTCOMB BOILER   /ELECTRIC GENERATN/RESIDUAL OIL       /L10MMBTU/HR GENL    /1000GALLONS BURNED
39   1 01 005 01 EXTCOMB BOILER   /ELECTRIC GENERATN/DISTILLATE OIL     /G100MMBTU/HR GENL   /1000GALLONS BURNED
40   1 01 005 02 EXTCOMB BOILER   /ELECTRIC GENERATN/DISTILLATE OIL     / 10-100MMBTU/HRGNL  /1000GALLONS BURNED
41   1 01 005 03 EXTCOMB BOILER   /ELECTRIC GENERATN/DISTILLATE OIL     /L10MMBTU/HR GENL    /1000GALLONS BURNED
42   1 01 006 01 EXTCOMB BOILER   /ELECTRIC GENERATN/NATURAL GAS        /G100MMBTU/HR        /MILLION CUBIC FEET BURNED
43   1 01 006 02 EXTCOMB BOILER   /ELECTRIC GENERATN/NATURAL GAS        / 10-100MMBTU/HR     /MILLION CUBIC FEET BURNED
44   1 01 006 03 EXTCOMB BOILER   /ELECTRIC GENERATN/NATURAL GAS        /L10MMBTU/HR         /MILLION CUBIC FEET BURNED
45   1 01 007 01 EXTCOMB BOILER   /ELECTRIC GENERATN/PROCESS GAS        /G100MMBTU/HR        /MILLION CUBIC FEET BURNED
46   1 01 007 02 EXTCOMB BOILER   /ELECTRIC GENERATN/PROCESS GAS        / 10-100MMBTU/HR     /MILLION CUBIC FEET BURNED
47   1 01 007 03 EXTCOMB BOILER   /ELECTRIC GENERATN/PROCESS GAS        /LL10MMBTU/HR        /MILLION CUBIC FEET BURNED
48   1 01 008 01 EXTCOMB BOILER   /ELECTRIC GENERATN/COKE               /G100MMBTU/HR        /TONS BURNED
49   1 01 011 02 EXTCOMB BOILER   /ELECTRIC GENERATN/BAGASSE            / 10-100MMBTU/HR     /TONS BURNED
50   1 01 011 03 EXTCOMB BOILER   /ELECTRIC GENERATN/BAGASSE            /L10MMBTU/HR         /TONS BURNED
51   1 01 012 01 EXTCOMB BOILER   /ELECTRIC GENERATN/SOLID WASTE/COAL /G100MMBTU/HR        /TONS BURNED
52   1 01 012 02 EXTCOMB BOILER   /ELECTRIC GENERATN/SOLID WASTE/COAL / 10-100MMBTU/HR     /TONS BURNED
53   1 01 012 03 EXTCOMB BOILER   /ELECTRIC GENERATN/SOLID WASTE/COAL /L10MMBTU/HR         /TONS BURNED
54   1 01 999 97 EXTCOMB BOILER   /ELECTRIC GENERATN/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /MILLION CUBIC FEET BURNED
55   1 01 999 98 EXTCOMB BOILER   /ELECTRIC GENERATN/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /1000 GALLON (LIQUID) BURNED
56   1 01 999 99 EXTCOMB BOILER   /ELECTRIC GENERATN/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS BURNED (SOLID)
57   1 02 001 01 EXTCOMB BOILER   /INDUSTRIAL          /ANTHRACITE COAL  /G100MMBTU/HR PULV  /TONS BURNED
58   1 02 001 02 EXTCOMB BOILER   /INDUSTRIAL          /ANTHRACITE COAL  /G100MMBTU/HR STKR  /TONS BURNED
59   1 02 001 03 EXTCOMB BOILER   /INDUSTRIAL          /ANTHRACITE COAL  / 10-100MMBTU PULVD /TONS BURNED
60   1 02 001 04 EXTCOMB BOILER   /INDUSTRIAL          /ANTHRACITE COAL  / 10-100MMBTU STKR  /TONS BURNED
61   1 02 001 05 EXTCOMB BOILER   /INDUSTRIAL          /ANTHRACITE COAL  /L10MMBTU/HR PULVD  /TONS BURNED
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62    1 02 001 06 EXTCOMB BOILER   /INDUSTRIAL        /ANTHRACITE COAL  /L10MMBTU/HR STKR   /TONS BURNED
63    1 02 001 07 EXTCOMB BOILER   /INDUSTRIAL        /ANTHRACITE COAL  /L10MMBTU/HR HNDFR  /TONS BURNED
64    1 02 001 99 EXTCOMB BOILER   /INDUSTRIAL        /ANTHRACITE COAL  / OTHER/NOT CLASIFD /TONS BURNED
65    1 02 002 01 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  /G100MMBTU PULVWET  /TONS BURNED
66    1 02 002 02 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  /G100MMBTU PULVDRY  /TONS BURNED
67    1 02 002 03 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  /G100MMBTU CYCLONE  /TONS BURNED
68    1 02 002 04 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  /G100MMBTU SPDSTKR  /TONS BURNED
69    1 02 002 05 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  / 10-100MMBTU UFSTK /TONS BURNED
70    1 02 002 06 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  / 10-100MMBTU UFSTK /TONS BURNED
71    1 02 002 07 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  / 10-100MMBTU PULWT /TONS BURNED
72    1 02 002 08 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  / 10-100MMBTU PULDY /TONS BURNED
73    1 02 002 09 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  / 10-100MMBTUSPDSTK /TONS BURNED
74    1 02 002 10 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  /L10MMBTU UFD STKR  /TONS BURNED
75    1 02 002 11 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  /L10MMBTU UFD STKR  /TONS BURNED
76    1 02 002 12 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  /L10MMBTU PULV DRY  /TONS BURNED
77    1 02 002 13 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  /L10MMBTU SPD STKR  /TONS BURNED
78    1 02 002 14 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  /L10MMBTU HANDFIRE  /TONS BURNED
79    1 02 002 99 EXTCOMB BOILER   /INDUSTRIAL        /BITUMINOUS COAL  / OTHER/NOT CLASIFD /TONS BURNED
80    1 02 003 01 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          /G100MMBTU PULVWET  /TONS BURNED
81    1 02 003 02 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          /G100MMBTU PULVDRY  /TONS BURNED
82    1 02 003 03 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          /G100MMBTU CYCLONE  /TONS BURNED
83    1 02 003 04 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          /G100MMBTU UFSTKR   /TONS BURNED
84    1 02 003 05 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          /G100MMBTU UFSTKR   /TONS BURNED
85    1 02 003 06 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          /G100MMBTU SPDSTKR  /TONS BURNED
86    1 02 003 07 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          / 10-100MMBTU DYPUL /TONS BURNED
87    1 02 003 08 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          / 10-100MMBTU WTPUL /TONS BURNED
88    1 02 003 09 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          / 10-100MMBTU OFSTK /TONS BURNED
89    1 02 003 10 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          / 10-100MMBTU UFSTK /TONS BURNED
90    1 02 003 11 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          / 10-100MMBTUSPDSTK /TONS BURNED
91    1 02 003 12 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          /L10MMBTU PULV DRY  /TONS BURNED
92    1 02 003 13 EXTCOMB BOILER   /INDUSTRIAL        /LIGNITE          /L10MMBTU UF STOKR  /TONS BURNED
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 93   1 02 003 14 EXTCOMB BOILER   /INDUSTRIAL       /LIGNITE          /L10MMBTU OFSTOKR   /TONS BURNED
 94   1 02 003 15 EXTCOMB BOILER   /INDUSTRIAL       /LIGNITE          /L10MMBTU HANDFIRE  /TONS BURNED
 95   1 02 003 16 EXTCOMB BOILE    /INDUSTRIAL       /LIGNITE          /L10MMBTU SPDSTKR   /TONS BURNED
 96   1 02 004 01 EXTCOMB BOILER   /INDUSTRIAL       /RESIDUAL OIL     /G100MMBTU/HR       /1000 GALLONS BURNED
 97   1 02 004 02 EXTCOMB BOILER   /INDUSTRIAL       /RESIDUAL OIL     / 10-100MMBTU/HR    /1000 GALLONS BURNED
 98   1 02 004 03 EXTCOMB BOILER   /INDUSTRIAL       /RESIDUAL OIL     /L10MMBTU/HR        /1000 GALLONS BURNED
 99   1 02 005 01 EXTCOMB BOILER   /INDUSTRIAL       /DISTILLATE OIL   /G100MMBTU/HR       /1000 GALLONS BURNED
100   1 02 005 02 EXTCOMB BOILER   /INDUSTRIAL       /DISTILLATE OIL   / 10-100MMBTU/HR    /1000 GALLONS BURNED
101   1 02 005 03 EXTCOMB BOILER   /INDUSTRIAL       /DISTILLATE OIL   /L10MMBTU/HR        /1000 GALLONS BURNED
102   1 02 006 01 EXTCOMB BOILER   /INDUSTRIAL       /NATURAL GAS      /G100MMBTU/HR       /MILLION CUBIC FEET BURNED
103   1 02 006 02 EXTCOMB BOILER   /INDUSTRIAL       /NATURAL GAS      / 10-100MMBTU/HR    /MILLION CUBIC FEET BURNED
104   1 02 006 03 EXTCOMB BOILER   /INDUSTRIAL       /NATURAL GAS      /L10MMBTU/HR        /MILLION CUBIC FEET BURNED
105   1 02 007 01 EXTCOMB BOILER   /INDUSTRIAL       /PROCESS GAS      /G100MMBTU/HR       /MILLION CUBIC FEET BURNED
106   1 02 007 02 EXTCOMB BOILER   /INDUSTRIAL       /PROCESS GAS      / 10-100MMBTU/HR    /MILLION CUBIC FEET BURNED
107   1 02 007 03 EXTCOMB BOILER   /INDUSTRIAL       /PROCESS GAS      /L10MMBTU/HR        /MILLION CUBIC FEET BURNED
108   1 02 008 02 EXTCOMB BOILER   /INDUSTRIAL       /COKE             / 10-100MMBTU/HR    /TONS BURNED
109   1 02 008 03 EXTCOMB BOILER   /INDUSTRIAL       /COKE             /L10MMBTU/HR        /TONS BURNED
110   1 02 009 02 EXTCOMB BOILER   /INDUSTRIAL       /WOOD             / WOOD WASTE BOILER /TONS BURNED
111   1 02 009 03 EXTCOMB BOILER   /INDUSTRIAL       /WOOD             / SMALL HANDFIRE    /TONS BURNED
112   1 02 010 02 EXTCOMB BOILER   /INDUSTRIAL       /LIQ PETROLEUM GAS/ 10-100MMBTU/HR    /1000 GALLONS BURNED
113   1 02 010 03 EXTCOMB BOILER   /INDUSTRIAL       /LIQ PETROLEUM GAS/L10MMBTU/HR        /1000 GALLONS BURNED
114   1 02 011 02 EXTCOMB BOILER   /INDUSTRIAL       /BAGASSE          / 10-100MMBTU/HR    /TONS BURNED
115   1 02 011 03 EXTCOMB BOILER   /INDUSTRIAL       /BAGASSE          /L10MMBTU/HR        /TONS BURNED
116   1 02 999 97 EXTCOMB BOILER   /INDUSTRIAL       /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /MILLION CUBIC FEET BURNED
117   1 02 999 98 EXTCOMB BOILER   /INDUSTRIAL       /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /1000 GALLON BURNED (LIQUID)
118   1 02 999 99 EXTCOMB BOILER   /INDUSTRIAL       /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS BURNED(SOLID)
119   1 03 001 05 EXTCOMB BOILER   /COMMERCL-INSTUTNL/ANTHRACITE COAL  / 10-100MMBTU PULWT /TONS BURNED
120   1 03 001 06 EXTCOMB BOILER   /COMMERCL-INSTUTNL/ANTHRACITE COAL  / 10-100MMBTU PULDY /TONS BURNED
121   1 03 001 07 EXTCOMB BOILER   /COMMERCL-INSTUTNL/ANTHRACITE COAL  / 10-100MMBTUSPDSTK /TONS BURNED
122   1 03 001 08 EXTCOMB BOILER   /COMMERCL-INSTUTNL/ANTHRACITE COAL  /L10MMBTU PULVIZED  /TONS BURNED
123   1 03 001 09 EXTCOMB BOILER   /COMMERCL-INSTUTNL/ANTHRACITE COAL  /L10MMBTU STOKER    /TONS BURNED
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124   1 03 001 10 EXTCOMB BOILER   /COMMERCL-INSTUTNL/ANTHRACITE COAL  /L10MMBTU SPOSTOKR  /TONS BURNED
125   1 03 001 99 EXTCOMB BOILER   /COMMERCL-INSTUTNL/ANTHRACITE COAL  / OTHER/NOT CLASIFD /TONS BURNED
126   1 03 002 05 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  / 10-100MMBTU PULWT /TONS BURNED
127   1 03 002 06 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  / 10-100MMBTU PULDY /TONS BURNED
128   1 03 002 07 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  / 10-100MMBTU OFSTK /TONS BURNED
129   1 03 002 08 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  / 10-100MMBTU UFSTK /TONS BURNED
130   1 03 002 09 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  / 10-100MMBTUSPOSTK /TONS BURNED
131   1 03 002 10 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  / 10-100MMBTU HANFR /TONS BURNED
132   1 03 002 11 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  /L10MMBTU OFSTOKER  /TONS BURNED
133   1 03 002 12 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  /L10MMBTU UFSTOKER  /TONS BURNED
134   1 03 002 13 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  /L10MMBTU SPOSTOKR  /TONS BURNED
135   1 03 002 14 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  /L10MMBTU HANDFIRE  /TONS BURNED
136   1 03 002 99 EXTCOMB BOILER   /COMMERCL-INSTUTNL/BITUMINOUS COAL  / OTHER/NOT CLASIFD /TONS BURNED
137   1 03 003 05 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIGNITE          / 10-100MMBTU PULWT /TONS BURNED
138   1 03 003 06 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIGNITE          / 10-100MMBTU PULDY /TONS BURNED
139   1 03 003 07 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIGNITE          / 10-100MMBTU OFSTK /TONS BURNED
140   1 03 003 08 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIGNITE          / 10-100MMBTU UFSTK /TONS BURNED
141   1 03 003 09 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIGNITE          / 10-100MMBTUSPOSTK /TONS BURNED
142   1 03 003 10 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIGNITE          /L10MMBTU PULV-DRY  /TONS BURNED
143   1 03 003 11 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIGNITE          /L10MMBTU OFSTOKER  /TONS BURNED
144   1 03 003 12 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIGNITE          /L10MMBTU UFSTOKER  /TONS BURNED
145   1 03 003 13 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIGNITE          /L10MMBTU SPOSTOKR  /TONS BURNED
146   1 03 003 14 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIGNITE          /L10MMBTU HANDFIRE  /TONS BURNED
147   1 03 004 01 EXTCOMB BOILER   /COMMERCL-INSTUTNL/RESIDUAL OIL     /G100MMBTU/HR       /1000 GALLONS BURNED
148   1 03 004 02 EXTCOMB BOILER   /COMMERCL-INSTUTNL/RESIDUAL OIL     / 10-100MMBTU/HR    /1000 GALLONS BURNED
149   1 03 004 03 EXTCOMB BOILER   /COMMERCL-INSTUTNL/RESIDUAL OIL     /L10MMBTU/HR        /1000 GALLONS BURNED
150   1 03 005 01 EXTCOMB BOILER   /COMMERCL-INSTUTNL/DISTILLATE       /G100MMBTU/HR       /1000 GALLONS BURNED
151   1 03 005 02 EXTCOMB BOILER   /COMMERCL-INSTUTNL/DISTILLATE       / 10-100MMBTU/HR    /1000 GALLONS BURNED
152   1 03 005 03 EXTCOMB BOILER   /COMMERCL-INSTUTNL/DISTILLATE       /L10MMBTU/HR        /1000 GALLONS BURNED
153   1 03 006 01 EXTCOMB BOILER   /COMMERCL-INSTUTNL/NATURAL GAS      /G100MMBTU/HR       /MILLION CUBIC FEET BURNED
154   1 03 006 02 EXTCOMB BOILER   /COMMERCL-INSTUTNL/NATURAL GAS      / 10-100MMBTU/HR    /MILLION CUBIC FEET BURNED
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155    1 03 006 03 EXTCOMB BOILER   /COMMERCL-INSTUTNL/NATURAL GAS       /L10MMBTU/HR         /MILLION CUBIC FEET BURNED
156    1 03 009 03 EXTCOMB BOILER   /COMMERCL-INSTUTNL/WOOD              /L10MMBTU/HR         /TONS BURNED
157    1 03 010 02 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIQ PETROLEUM GAS/ 10-100MMBTU/HR      /1000 GALLONS BURNED
158    1 03 010 03 EXTCOMB BOILER   /COMMERCL-INSTUTNL/LIQ PETROLEUM GAS/L10MMBTU/HR          /1000 GALLONS BURNED
159    1 03 999 97 EXTCOMB BOILER   /COMMERCL-INSTUTNL/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /MILLION CUBIC FEET BURNED
160    1 03 999 98 EXTCOMB BOILER   /COMMERCL-INSTUTNL/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /1000 GALLON BURNED (LIQUID)
161    1 03 999 99 EXTCOMB BOILER   /COMMERCL-INSTUTNL/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS BURNED (SOLID)
162    2 01 001 01 INTERNLCOMBUSTION/ELECTRIC GENERATN/DISTILLATE OIL    / TURBINE             /1000 GALLONS BURNED
163    2 01 002 01 INTERNLCOMBUSTION/ELECTRIC GENERATN/NATURAL GAS       / TURBINE             /MILLION CUBIC FEET
164    2 01 003 01 INTERNLCOMBUSTION/ELECTRIC GENERATN/DIESEL            / RECIPROCATING       /THOUSANDS OF GALLONS
165    2 01 999 97 INTERNLCOMBUSTION/ELECTRIC GENERATN/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /MILLION CUBIC FEET BURNED
166    2 01 999 98 INTERNLCOMBUSTION/ELECTRIC GENERATN/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /1000 GALLONS BURNED
167    2 02 001 01 INTERNLCOMBUSTION/INDUSTRIAL        /DISTILLATE OIL   / TURBINE             /1000 GALLONS BURNED
168    2 02 001 02 INTERNLCOMBUSTION/INDUSTRIAL        /DISTILLATE OIL   / RECIPROCATING       /1000 GALLONS BURNED
169    2 02 002 01 INTERNLCOMBUSTION/INDUSTRIAL        /NATURAL GAS      / TURBINE             /MILLION CUBIC FEET
170    2 02 002 02 INTERNLCOMBUSTION/INDUSTRIAL        /NATURAL GAS      / RECIPROCATING       /MILLION CUBIC FEET
171    2 02 003 01 INTERNLCOMBUSTION/INDUSTRIAL        /GASOLINE         / RECIPROCATING       /1000 GALLONS BURNED
172    2 02 004 01 INTERNLCOMBUSTION/INDUSTRIAL        /DIESEL FUEL      / RECIPROCATING       /1000 GALLONS BURNED
173    2 02 999 97 INTERNLCOMBUSTION/INDUSTRIAL        /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /MILLION CUBIC FEET BURNED
174    2 02 999 98 INTERNLCOMBUSTION/INDUSTRIAL        /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /1000 GALLONS BURNED
175    2 03 001 01 INTERNLCOMBUSTION/COMMERCL-INSTUTNL/DIESEL            / RECIPROCATING       /THOUSANDS OF GALLONS
176    2 03 999 97 INTERNLCOMBUSTION/COMMERCL-INSTUTNL/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /MILLION CUBIC FEET BURNED
177    2 03 999 98 INTERNLCOMBUSTION/COMMERCL-INSTUTNL/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /1000 GALLONS BURNED
178    2 04 001 01 INTERNLCOMBUSTION/ENGINE TESTING   /AIRCRAFT          / TURBOJET            /THOUSANDS OF GALLON/FUEL
179    3 01 001 01 INDUSTRIAL PROCES/CHEMICAL MFG     /ADIPIC ACID PROD / GENERAL-CYCLOHEX  /TONS PRODUCED
180    3 01 001 99 INDUSTRIAL PROCES/CHEMICAL MFG     /ADIPIC ACID PROD / OTHER/NOT CLASIFD /TONS PRODUCED
181    3 01 002 01 INDUSTRIAL PROCES/CHEMICAL MFG     /AMMONIA W/METHNTR/ PURGE GAS         /TONS PRODUCED
182    3 01 002 02 INDUSTRIAL PROCES/CHEMICAL MFG     /AMMONIA W/METHNTR/ STORAGE/LOADING   /TONS PRODUCED
183    3 01 003 01 INDUSTRIAL PROCES/CHEMICAL MFG     /AMMONIA W/COABSRB/ REGENERATOR EXIT  /TONS PRODUCED
184    3 01 003 02 INDUSTRIAL PROCES/CHEMICAL MFG     /AMMONIA W/COABSRB/ PURGE GAS         /TONS PRODUCED
185    3 01 003 03 INDUSTRIAL PROCES/CHEMICAL MFG     /AMMONIA W/COABSRB/ STORAGE/LOADING   /TONS PRODUCED
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186   3 01 003 99 INDUSTRIAL PROCES/CHEMICAL MFG    /AMMONIA           / OTHER/NOT CLASIFD /TONS PRODUCED
187   3 01 004 01 INDUSTRIAL PROCES/CHEMICAL MFG    /AMMONIUM NITRATE / GENERAL           /TONS PRODUCED
188   3 01 004 99 INDUSTRIAL PROCES/CHEMICAL MFG    /AMMONIUM NITRATE / OTHER/NOT CLASIFD /TONS PRODUCED
189   3 01 005 01 INDUSTRIAL PROCES/CHEMICAL MFG .  /CARBON BLACK      / CHANNEL PROCESS   /TONS PRODUCED
190   3 01 005 02 INDUSTRIAL PROCES/CHEMICAL MFG    /CARBON BLACK      / THERMAL PROCESS   /TONS PRODUCED
191   3 01 005 03 INDUSTRIAL PROCES/CHEMICAL MFG    /CARBON BLACK      / FURNACE PROC GAS  /TONS PRODUCED
192   3 01 005 04 INDUSTRIAL PROCES/CHEMICAL MFG    /CARBON BLACK      / FURNACE PROC OIL  /TONS PRODUCED
193   3 01 005 05 INDUSTRIAL PROCES/CHEMICAL MFG    /CARBON BLACK      / FURNACE W/GAS/OIL /TONS PRODUCED
194   3 01 005 99 INDUSTRIAL PROCES/CHEMICAL MFG    /CARBON BLACK      / OTHER/NOT CLASFD  /TONS PRODUCED
195   3 01 006 01 INDUSTRIAL PROCES/CHEMICAL MFG    /CHARCOAL MFG      / PYROL/DISTIL/GENL /TONS PRODUCED
196   3 01 006 99 INDUSTRIAL PROCES/CHEMICAL MFG    /CHARCOAL MFG      / OTHER/NOT CLASFD  /TONS PRODUCED
197   3 01 007 01 INDUSTRIAL PROCES/CHEMICAL MFG    /CHLORINE          / GENERAL           /TONS PRODUCED
198   3 01 007 99 INDUSTRIAL PROCES/CHEMICAL MFG    /CHLORINE          / OTHER/NOT CLASIFD /TONS PRODUCED
199   3 01 008 01 INDUSTRIAL PROCES/CHEMICAL MFG    /CHLOR-ALKALI      / LIQUIFTN-DIAPHRGM /100 TONS CHLORINE LIQUEFIED
200   3 01 008 02 INDUSTRIAL PROCES/CHEMICAL MFG    /CHLOR-ALKALI      / LIQUIFTN-MERC CEL /100 TONS CHLORINE LIQUEFIED
201   3 01 008 03 INDUSTRIAL PROCES/CHEMICAL MFG    /CHLOR-ALKALI      / LOADING TNKCARVNT /100 TONS CHLORINE LIQUEFIED
202   3 01 008 04 INDUSTRIAL PROCES/CHEMICAL MFG    /CHLOR-ALKALI      / LOADING STGTNKVNT /100 TONS CHLORINE LIQUEFIED
203   3 01 008 05 INDUSTRIAL PROCES/CHEMICAL MFG    /CHLOR-ALKALI      / AIR-BLOW MC BRINE /100 TONS CHLORINE LIQUEFIED
204   3 01 008 99 INDUSTRIAL PROCES/CHEMICAL MFG    /CHLOR-ALKALI      / OTHER/NOT CLASIFD /100 TONS CHLORINE LIQUEFIED
205   3 01 009 01 INDUSTRIAL PROCES/CHEMICAL MFG    /CLEANING CHEMICLS/ SOAP/DET SPRYDRYR /TONS PRODUCED
206   3 01 009 10 INDUSTRIAL PROCES/CHEMICAL MFG    /CLEANING CHEMICLS/ SPECIALTY CLEANRS /TONS PRODUCED
207   3 01 009 99 INDUSTRIAL PROCES/CHEMICAL MFG    /CLEANING CHEMICLS/ OTHERS/NOT CLASFD /TONS PRODUCED
208   3 01 010 01 INDUSTRIAL PROCES/CHEMICAL MFG    /EXPLOSIVES-TNT    / NITRATION REACTRS /TONS PRODUCED
209   3 01 010 02 INDUSTRIAL PROCES/CHEMICAL MFG    /EXPLOSIVES-TNT    / HNO3   CONCTRTRS  /TONS PRODUCED
210   3 01 010 03 INDUSTRIAL PROCES/CHEMICAL MFG    /EXPLOSIVES-TNT    /H2SO4  REGENERATN  /TONS PRODUCED
211   3 01 010 04 INDUSTRIAL PROCES/CHEMICAL MFG    /EXPLOSIVES-TNT    / RED WATER INCIN   /TONS PRODUCED
212   3 01 010 05 INDUSTRIAL PROCES/CHEMICAL MFG    /EXPLOSIVES-TNT    / OPEN WASTE BURN   /TONS BURNED
213   3 01 010 99 INDUSTRIAL PROCES/CHEMICAL MFG    /EXPLOSIVES        / OTHER/NOT CLASIFD /TONS PRODUCED
214   3 01 011 01 INDUSTRIAL PROCES/CHEMICAL MFG    /HYDROCHLORIC ACID/ BYPRODUCTW/OSCRUB /TONS FINAL ACID
215   3 01 011 02 INDUSTRIAL PROCES/CHEMICAL MFG    /HYDROCHLORIC ACID/ BYPRODUCT W/SCRUB /TONS FINAL ACID
216   3 01 011 99 INDUSTRIAL PROCES/CHEMICAL MFG    /HYDROCHLORIC ACID/ OTHER/NOT CLASIFD /TONS FINAL ACID
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217   3 01 012 01 INDUSTRIAL PROCES/CHEMICAL MFG    /HYDROFLUORIC ACID/ ROTRYKILNW/SCRUBR /TONS ACID
218   3 01 012 02 INDUSTRIAL PROCES/CHEMICAL MFG    /HYDROFLUORIC ACID/ ROTRYKILNW/OSCRUB /TONS ACID
219   3 01 012 03 INDUSTRIAL PROCES/CHEMICAL MFG    /HYDROFLUORIC ACID/ GRIND/DRY FLUOSPR /TONS FLUORSPAR
220   3 01 012 99 INDUSTRIAL PROCES/CHEMICAL MFG    /HYDROFLUORIC ACID/ OTHER/NOT CLASIFD /TONS ACID
221   3 01 013 01 INDUSTRIAL PROCES/CHEMICAL MFG    /NITRIC ACID      / AMMONIAOXIDATNOLD /TONS PURE ACID PRODUCED
222   3 01 013 02 INDUSTRIAL PROCES/CHEMICAL MFG    /NITRIC ACID      / AMMONIAOXIDATNNEW /TONS PURE ACID PRODUCED
223   3 01 013 03 INDUSTRIAL PROCES/CHEMICAL MFG    /NITRIC ACID      / NITACD CONCTR OLD /TONS PURE ACID PRODUCED
224   3 01 013 04 INDUSTRIAL PROCES/CHEMICAL MFG    /NITRIC ACID      / NITACD CONCTR NEW /TONS PURE ACID PRODUCED
225   3 01 013 05 INDUSTRIAL PROCES/CHEMICAL MFG    /NITRIC ACID-WEAK / UNCONTROLLED      /TONS PURE ACID PRODUCED
226   3 01 013 06 INDUSTRIAL PROCES/CHEMICAL MFG    /NITRIC ACID-WEAK / W/CATYL/COMBUSTER /TONS PURE ACID PRODUCED
227   3 01 013 07 INDUSTRIAL PROCES/CHEMICAL MFG    /NITRIC ACID-STRNG/ UNCONTROLLED      /TONS PURE ACID PRODUCED
228   3 01 013 08 INDUSTRIAL PROCES/CHEMICAL MFG    /NITRIC ACID-STRNG/ W/ABSORBERS       /TONS PURE ACID PRODUCED
229   3 01 013 99 INDUSTRIAL PROCES/CHEMICAL MFG    /NITRIC ACID      / OTHER/NOT CLASIFD /TONS PURE ACID PRODUCED
230   3 01 014 01 INDUSTRIAL PROCES/CHEMICAL MFG    /PAINT MFG        / GENERAL           /TONS PRODUCED
231   3 01 014 02 INDUSTRIAL PROCES/CHEMICAL MFG    /PAINT MFG        / PIGMENT KILN      /TONS PRODUCT
232   3 01 014 99 INDUSTRIAL PROCES/CHEMICAL MFG    /PAINT MFG        / OTHER/NOT CLASFD  /TONS PRODUCT
233   3 01 015 01 INDUSTRIAL PROCES/CHEMICAL MFG    /VARNISH MFG      / BODYING OIL GENL  /TONS PRODUCED
234   3 01 015 02 INDUSTRIAL PROCES/CHEMICAL MFG    /VARNISH MFG      / OLEORESINOUS GENL /TONS PRODUCED
235   3 01 015 03 INDUSTRIAL PROCES/CHEMICAL MFG    /VARNISH MFG      / ALKYD GENERAL     /TONS PRODUCED
236   3 01 015 05 INDUSTRIAL PROCES/CHEMICAL MFG    /VARNISH MFG      / ACRYLIC GENERAL   /TONS PRODUCED
237   3 01 015 99 INDUSTRIAL PROCES/CHEMICAL MFG    /VARNISH MFG      / OTHER/NOT CLASFD  /TONS PRODUCED
238   3 01 016 01 INDUSTRIAL PROCES/CHEMICAL MFG    /PHOS-ACID WETPROC/ REACTOR-UNCONTLD  /TONS PHOSPHATE ROCK
239   3 01 016 02 INDUSTRIAL PROCES/CHEMICAL MFG    /PHOS-ACID WETPROC/ GYPSUM POND       /TONS PHOSPHATE ROCK
240   3 01 016 03 INDUSTRIAL PROCES/CHEMICAL MFG    /PHOS-ACID WETPROC/ CONDENSR-UNCONTLD /TONS PHOSPHATE ROCK
241   3 01 016 99 INDUSTRIAL PROCES/CHEMICAL MFG    /PHOS-ACID WETPROC/ OTHER/NOT CLASFD  /TONS PRODUCED
242   3 01 017 01 INDUSTRIAL PROCES/CHEMICAL MFG    /PHOS-ACID THERMAL/ GENERAL           /TONS PHOSPHOROUS BURNED
243   3 01 017 99 INDUSTRIAL PROCES/CHEMICAL MFG    /PHOS-ACID THERMAL/ OTHER/NOT CLASFD  /TONS PRODUCED
244   3 01 018 01 INDUSTRIAL PROCES/CHEMICAL MFG    /PLASTICS         / PVC-GENERAL       /TONS PRODUCED
245   3 01 018 02 INDUSTRIAL PROCES/CHEMICAL MFG    /PLASTICS         / POLYPROP-GENERAL  /TONS PRODUCED
246   3 01 018 05 INDUSTRIAL PROCES/CHEMICAL MFG    /PLASTICS         / BAKELITE-GENERAL  /TONS PRODUCT
247   3 01 018 99 INDUSTRIAL PROCES/CHEMICAL MFG    /PLASTICS         / OTHER/NOT CLASFD  /TONS PRODUCED
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248   3 01 019 03 INDUSTRIAL PROCES/CHEMICAL MFG     /PHTHALIC ANHYDRID/ UNCONTROLLED-GENL /TONS PRODUCED
249   3 01 020 01 INDUSTRIAL PROCES/CHEMICAL MFG     /PRINTING INK     / COOKING-GENERAL   /TONS PRODUCED
250   3 01 020 02 INDUSTRIAL PROCES/CHEMICAL MFG     /PRINTING INK     / COOKING-OILS      /TONS PRODUCED
251   3 01 020 03 INDUSTRIAL PROCES/CHEMICAL MFG     /PRINTING INK     / COOKING-OLEORESIN /TONS PRODUCED
252   3 01 020 04 INDUSTRIAL PROCES/CHEMICAL MFG     /PRINTING INK     / COOKING-ALKYDS    /TONS PRODUCED
253   3 01 020 05 INDUSTRIAL PROCES/CHEMICAL MFG     /PRINTING INK     / PIGMENT MIXINGGEN /TONS PIGMENT
254   3 01 020 99 INDUSTRIAL PROCES/CHEMICAL MFG     /PRINTING INK     / OTHER/NOT CLASFD  /TONS PRODUCED
255   3 01 021 01 INDUSTRIAL PROCES/CHEMICAL MFG     /SODIUM CARBONATE / AMMONIA RECOVERY  /TONS PRODUCED
256   3 01 021 02 INDUSTRIAL PROCES/CHEMICAL MFG     /SODIUM CARBONATE / HANDLING          /TONS PRODUCED
257   3 01 021 99 INDUSTRIAL PROCES/CHEMICAL MFG     /SODIUM CARBONATE / OTHER/NOT CLASFD  /TONS PRODUCED
258   3 01 022 01 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4 -CHAMBER   / GENERAL           /TONS PURE ACID PRODUCED
259   3 01 023 01 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4-CONTACT    / 99.7 CONVERSION   /TONS PURE ACID PRODUCED
260   3 01 023 04 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4-CONTACT    / 99.5 CONVERSION   /TONS PURE ACID PRODUCED
261   3 01 023 06 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4-CONTACT    / 99.0 CONVERSION   /TONS PURE ACID PRODUCED
262   3 01 023 08 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4-CONTACT    / 98.0 CONVERSION   /TONS PURE ACID PRODUCED
263   3 01 023 10 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4-CONTACT    / 97.0 CONVERSION   /TONS PURE ACID PRODUCED
264   3 01 023 12 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4-CONTACT    / 96.0 CONVERSION   /TONS PURE ACID PRODUCED
265   3 01 023 14 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4-CONTACT    / 95.0 CONVERSION   /TONS PURE ACID PRODUCED
266   3 01 023 16 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4-CONTACT    / 94.0 CONVERSION   /TONS PURE ACID PRODUCED
267   3 01 023 18 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4-CONTACT    / 93.0 CONVERSION   /TONS PURE ACID PRODUCED
268   3 01 023 99 INDUSTRIAL PROCES/CHEMICAL MFG     /H2SO4-CONTACT    / OTHER/NOT CLASFD  /TONS PRODUCED
269   3 01 024 01 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / NYLON GENERAL     /TONS FIBER
270   3 01 024 02 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / DACRON GENERAL    /TONS FIBER
271   3 01 024 03 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / ORLON             /TONS PRODUCT
272   3 01 024 04 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / ELASTIC           /TONS PRODUCT
273   3 01 024 05 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / TEFLON            /TONS PRODUCT
274   3 01 024 06 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / POLYESTER         /TONS PRODUCT
275   3 01 024 08 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / NOMEX             /TONS PRODUCT
276   3 01 024 10 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / ACRYLIC           /TONS PRODUCT
277   3 01 024 12 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / TYVEX             /TONS PRODUCT
278   3 01 024 14 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / OLEFINS           /TONS PRODUCT
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279    3 01 024 99 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC FIBERS / OTHERS/NOT CLASFD /TONS PRODUC D
280    3 01 025 01 INDUSTRIAL PROCES/CHEMICAL MFG     /SEMISYNTHTICFIBR / RAYON GENERAL     /TONS FIBER
281    3 01 025 05 INDUSTRIAL PROCES/CHEMICAL MFG     /SEMISYNTHTICFIBR / ACETATE           /TONS PRODUCED
282    3 01 025 10 INDUSTRIAL PROCES/CHEMICAL MFG     /SEMISYNTHETICFIBR/ VISCOSE           /TONS PRODUCED
283    3 01 025 99 INDUSTRIAL PROCES/CHEMICAL MFG     /SEMISYNTHTICFIBR / OTHERS/NOT CLASFD /TONS PRODUCED
284    3 01 026 01 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / BUTADIENE-GENERAL /TONS PRODUCT
285    3 01 026 02 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / METHYLPROPENE-GNL /TONS PRODUCT
286    3 01 026 03 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / BUTYNE GENERAL    /TONS PRODUCT
287    3 01 026 04 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / PENTADIENE-GENRL  /TONS PRODUCT
288    3 01 026 05 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / DIMETHHEPTNE GENL /TONS PRODUCT
289    3 01 026 06 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / PENTANE-GENERAL   /TONS PRODUCT
290    3 01 026 07 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / ETHANENITRILE-GEN /TONS PRODUCT
291    3 01 026 08 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / ACRYLONITRILE-GEN /TONS PRODUCT
292    3 01 026 09 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / ACROLEIN-GENERAL  /TONS PRODUCT
293    3 01 026 20 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / AUTO TIRES GENERL /TONS PRODUCT
294    3 01 026 99 INDUSTRIAL PROCES/CHEMICAL MFG     /SYNTHETIC RUBBER / OTHER/NOT CLASFD  /TONS PRODUCT
295    3 01 027 01 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ AMONNITR/ PRILTWR-NEUTRLIZR /TONS PRODUCED
296    3 01 027 02 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ AMONNITR/ PRILLING TOWER    /TONS PRODUCED
297    3 01 027 03 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ AMONNITR/ PRILTWR-DRYCOOLRS /TONS PRODUCED
298    3 01 027 04 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ AMONNITR/ GRANULAT-NEUTLIZR /TONS PRODUCED
299    3 01 027 05 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ AMONNITR/ GRANULATOR        /TONS PRODUCED
300    3 01 027 06 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ AMONNITR/ GRANULAT-DRYCOOLR /TONS PRODUCED
301    3 01 028 01 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ-NSUPPHOS/ GRIND-DRY         /TONS PRODUCED
302    3 01 028 02 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ-NSUPPHOS/ MAIN STACK        /TONS PRODUCED
303    3 01 029 01 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ-TRPSPHOS/ RUN OF PILE       /TONS PRODUCED
304    3 01 029 02 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ-TRPSPHOS/ GRANULAR          /TONS PRODUCED
305    3 01 030 01 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ-DIAMPHOS/ DRYER-COOLERS     /TONS PRODUCED
306    3 01 030 02 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZ-DIAMPHOS/ AMONIAT-GRANULATE /TONS PRODUCED
307    3 01 030 99 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZER       / OTHER/NOT CLASIFD /TONS PRODUCED
308    3 01 031 01 INDUSTRIAL PROCES/CHEMICAL MFG     /TEREPTHALIC ACID / HNO3+PARAXYLENGEN /TONS PRODUCED
309    3 01 031 99 INDUSTRIAL PROCES/CHEMICAL MFG     /TEREPTHALIC ACID / OTHER/NOT CLASIFD /TONS PRODUCED
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310    3 01 032 01 INDUSTRIAL PROCES/CHEMICAL MFG     /SULFUR(ELEMENTAL)/ MOD-CLAUS 2STAGE  /TONS PRODUCT
311    3 01 032 02 INDUSTRIAL PROCES/CHEMICAL MFG     /SULFUR(ELEMENTAL)/ MOD-CLAUS 3STAGE  /TONS PRODUCT
312    3 01 032 03 INDUSTRIAL PROCES/CHEMICAL MFG     /SULFUR(ELEMENTAL)/ MOD-CLAUS 4STAGE  /TONS PRODUCT
313    3 01 032 99 INDUSTRIAL PROCES/CHEMICAL MFG     /SULFUR(ELEMENTAL)/ OTHER/NOT CLASIFD /TONS PRODUCT
314    3 01 033 01 INDUSTRIAL PROCES/CHEMICAL MFG     /PESTICIDES       / MALATHION         /GALLONS OF PRODUCT
315    3 01 033 99 INDUSTRIAL PROCES/CHEMICAL MFG     /PESTICIDES       / OTHER/NOT CLASIFD /TONS PRODUCED
316    3 01 034 01 INDUSTRIAL PROCES/CHEMICAL MFG     /AMINES/AMIDES    / GENERAL/OTHER     /TONS PRODUCT
317    3 01 035 01 INDUSTRIAL PROCES/CHEMICAL MFG     /PIGMENT-INORGAN  / CALCINATION       /TONS OF PRODUCT
318    3 01 035 99 INDUSTRIAL PROCES/CHEMICAL MFG     /PIGMENT-INORGAN  / OTHER/NOT CLASIFD /TONS OF PRODUCT
319    3 01 036 01 INDUSTRIAL PROCES/CHEMICAL MFG     /SODIUM SULFATE   / GENERAL/OTHER     /TONS PRODUCT
320    3 01 036 02 INDUSTRIAL PROCES/CHEMICAL MFG     /SODIUM SULFATE   / KILNS             /TONS PRODUCT
321    3 01 037 01 INDUSTRIAL PROCES/CHEMICAL MFG     /SODIUM SULFATE   / GENERAL/OTHER     /TONS PRODUCT
322    3 01 037 02 INDUSTRIAL PROCES/CHEMICAL MFG     /SODIUM SULFATE   / KILNS             /TONS PRODUCT
323    3 01 038 01 INDUSTRIAL PROCES/CHEMICAL MFG     /SODIUM BICARB    / GENERAL           /TONS PRODUCT
324    3 01 039 01 INDUSTRIAL PROCES/CHEMICAL MFG     /LITHIUM HYDROXIDE/ GENERAL           /TONS PRODUCT
325    3 01 040 01 INDUSTRIAL PROCES/CHEMICAL MFG     /FERTILIZER UREA  / GENERAL           /TONS PRODUCT
326    3 01 050 01 INDUSTRIAL PROCES/CHEMICAL MFG     /ADHESIVES        / GENL/COMPND UNKWN /TONS PRODUCT
327    3 01 090 99 INDUSTRIAL PROCES/CHEMICAL MFG     /ACETATE FLAKE    / OTHER/NOT CLASFD  /TONS PRODUCT
328    3 01 091 01 INDUSTRIAL PROCES/CHEMICAL MFG     /ACETONE          / OTHER/NOT CLASFD  /TONS PRODUCT
329    3 01 100 01 INDUSTRIAL PROCES/CHEMICAL MFG     /MALEIC ANHYDRIDE / GENERAL/OTHER     /TONS PRODUCT
330    3 01 101 01 INDUSTRIAL PROCES/CHEMICAL MFG     /POLVINL PYRILIDON/ GENERAL/OTHER     /TONS PRODUCT
331    3 01 110 01 INDUSTRIAL PROCES/CHEMICAL MFG     /SULFONIC ACID/ATS/ GENERAL/OTHER     /TONS PRODUCT
332    3 01 900 99 INDUSTRIAL PROCES/CHEMICAL MFG     /WASTE GAS FLARES / OTHER/NOT CLASIFD /MILLION CUBIC FEET BURNED
333    3 01 999 99 INDUSTRIAL PROCES/CHEMICAL MFG     /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS PRODUCT
334    3 02 001 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/ALFALFA DEHYDRATN/ GENERAL           /TONS MEAL PRODUCED
335    3 02 001 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/ALFALFA DEHYDRATN/ OTHER/NOT CLASFD  /TONS PRODUCT
336    3 02 002 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/COFFEE ROASTING  / DIRECTFIRE ROASTR /TONS GREEN BEANS
337    3 02 002 02 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/COFFEE ROASTING  / INDIRCTFIREROASTR /TONS GREEN BEANS
338    3 02 002 03 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/COFFEE ROASTING  / STONER/COOLER     /TONS GREEN BEANS
339    3 02 002 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/COFFEE ROASTING  / OTHER/NOT CLASFD  /TONS PRODUCT
340    3 02 003 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/COFFEE-INSTANT   / SPRAY DRIER       /TONS GREEN BEANS
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341     3 02 004 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/COTTON GINNING   / UNLOADING FAN      /BALES COTTON
342     3 02 004 02 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/COTTON GINNING   / CLEANER            /BALES COTTON
343     3 02 004 03 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/COTTON GINNING   / STICK/BURR MACHNE /BALES COTTON
344     3 02 004 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/COTTON GINNING   / OTHER/NOT CLASFD  /BALES COTTON
345     3 02 005 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED/GRAIN TERMEL/ SHIPING/RECEIVING /TONS GRAIN PROCESSED
346     3 02 005 02 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED/GRAIN TERMEL/ TRANSFER/CONVEYNG /TONS GRAIN PROCESSED
347     3 02 005 03 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED/GRAIN TERMEL/ SCREENING/CLEANNG /TONS GRAIN PROCESSED
348     3 02 005 04 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED/GRAIN TERMEL/ DRYING            /TONS GRAIN PROCESSED
349     3 02 006 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED/GRAIN CNTRYE/ SHIPNG/RECEIVNG   /TONS GRAIN PROCESSED
350     3 02 006 02 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED/GRAIN CNTRYE/ TRANSFER/CONVEYNG /TONS GRAIN PROCESSED
351     3 02 006 03 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED/GRAIN CNTRYE/ SCREENING/CLEANNG /TONS GRAIN PROCESSED
352     3 02 006 04 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED/GRAIN CNTRYE/ DRYING            /TONS GRAIN PROCESSED
353     3 02 006 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED/GRAIN       / OTHER/NOT CLASIFD /TONS GRAIN PROCESSED
354     3 02 007 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/GRAIN PROCESSING / CORN MEAL         /TONS GRAIN PROCESSED
355     3 02 007 02 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/GRAIN PROCESSING / SOY BEAN          /TONS GRAIN PROCESSED
356     3 02 007 03 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/GRAIN PROCESSING / BARLEY/WHEATCLEAN /TONS GRAIN PROCESSED
357     3 02 007 04 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/GRAIN PROCESSING / MILO CLEANER      /TONS GRAIN PROCESSED
358     3 02 007 05 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/GRAIN PROCESSING / BARLEYFLOUR MILL  /TONS GRAIN PROCESSED
359     3 02 007 06 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/GRAIN PROCESSING / WET CORN MILLING  /TONS OF PRODUCT
360     3 02 007 30 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/GRAIN PROCESSING / WHEAT FLOUR MILL  /TONS PRODUCT
361     3 02 007 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/GRAIN PROCESSING / OTHER/NOT CLASFD  /TONS PROCESSED
362     3 02 008 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED MANUFACTURE / BARLEY FEED-GENL  /TONS GRAIN PROCESSED
363     3 02 008 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FEED MANUFACTURE / OTHER/NOT CLASFD  /TONS PROCESSED
364     3 02 009 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FERMENTATN-BEER  / GRAIN HANDLING    /TONS GRAIN PROCESSED
365     3 02 009 02 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FERMENTAIN-BEER  / DRYING SPNT GRAIN /TONS GRAIN PROCESSED
366     3 02 009 03 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FERMENTATION-BEER/ BREWING           /THOUSANDS OF GALLONS
367     3 02 009 98 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FERMENTATION-BEER/ OTHER/NOT CLASFD  /GALLONS PRODUCT
368     3 02 009 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FERMENTATION-BEER/ OTHER/NOT CLASFD  /TONS GRAIN PROCESSED
369     3 02 010 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FERMENTATN-WHISKY/ GRAIN HANDLING    /TONS GRAIN PROCESSED
370     3 02 010 02 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FERMENTATN-WHISKY/ DRYING SPNT GRAIN /TONS GRAIN PROCESSED
371     3 02 010 03 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FERMENTATN-WHISKY/ AGING             /TONS GRAIN PROCESSED
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372    3 02 010 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FERMENTATN-WHISKY/ OTHER/NOT CLASFD  /GALLONS PRODUCT
373    3 02 011 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FERMENTATN-WINE  / GENERAL            /GALLONS PRODUCT
374    3 02 012 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FISH MEAL        / COOKERS-FRESHFISH /TONS FISH MEAL PRODUCED
375    3 02 012 02 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FISH MEAL        / COOKERS-STALEFISH /TONS FISH MEAL PRODUCED
376    3 02 012 03 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FISH MEAL        / DRIERS            /TONS FISH SCRAP
377    3 02 012 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/FISH MEAL        / OTHER/NOT CLASIFD /TONS PROCESSED
378    3 02 013 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/MEAT SMOKING     / GENERAL           /TONS MEAT SMOKED
379    3 02 014 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/STARCH MFG       / GENERAL           /TONS STARCH PRODUCED
380    3 02 015 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/SUGAR CANE PROCES/ GENERAL           /TONS SUGAR PRODUCED
381    3 02 015 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/SUGAR CANE PROCES/ OTHER/NOT CLASIFD /TONS PROCESSED
382    3 02 016 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/SUGAR BEET PROCES/ DRYER ONLY        /TONS RAW BEETS
383    3 02 016 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/SUGAR BEET PROCES/ OTHER/NOT CLASIFD /TONS RAW BEETS
384    3 02 017 20 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/PEANUT PROCESSING/ OIL/NOT CLASFD    /TONS PRODUCT
385    3 02 017 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/PEANUT PROCESSING/ OTHER/NOT CLASFD  /TONS PROCESSED
386    3 02 018 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/CANDY/CONFECTNRY / OTHER/NOT CLASFD  /TONS PRODUCT
387    3 02 030 01 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/DAIRY PRODUCTS   / MILK SPRAY-DRYER  /TONS PRODUCT
388    3 02 030 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/DAIRY PRODUCTS   / OTHER/NOT CLASFD  /TONS PRODUCT
389    3 02 999 98 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS PROCESSED (INPUT)
390    3 02 999 99 INDUSTRIAL PROCES/FOOD/AGRICULTURAL/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS PRODUCED (FINISHED)
391    3 03 000 01 INDUSTRIAL PROCES/PRIMARY METALS   /ALUMINUM ORE-BAUX/ CRUSHING/HANDLING /TONS OF ORE
392    3 03 001 01 INDUSTRIAL PROCES/PRIMARY METALS   /AL ORE-ELECROREDN/ PREBAKE CELLS     /TONS ALUMINUM PRODUCED
393    3 03 001 02 INDUSTRIAL PROCES/PRIMARY METALS   /AL ORE-ELECROREDN/ HORIZSTD SODERBRG /TONS ALUMINUM PRODUCED
394    3 03 001 03 INDUSTRIAL PROCES/PRIMARY METALS   /AL ORE-ELECROREDN/ VERTSTD SODERBERG /TONS ALUMINUM PRODUCED
395    3 03 001 04 INDUSTRIAL PROCES/PRIMARY METALS   /AL ORE-ELECROREDN/ MATERIALS HANDLNG /TONS ALUMINUM PRODUCED
396    3 03 001 05 INDUSTRIAL PROCES/PRIMARY METALS   /AL ORE-ELECROREDN/ ANODE BAKE FURNCE /TONS ALUMINUM PRODUCED
397    3 03 001 99 INDUSTRIAL PROCES/PRIMARY METALS   /ALUMINUM OPERATN / OTHER/NOT CLASFD  /TONS ALUMINUM PRODUCED
398    3 03 002 01 INDUSTRIAL PROCES/PRIMARY METALS   /AL ORE-CALC ALHYD/ GENERAL           /TONS ALUMINUM PRODUCED
399    3 03 003 01 INDUSTRIAL PROCES/PRIMARY METALS   /COKE MET BYPRODUC/ TGENERAL          /TONS COAL CHARGED
400    3 03 003 02 INDUSTRIAL PROCES/PRIMARY METALS   /COKE-MET BYPRODUC/ OVEN CHARGING     /TONS COAL CHARGED
401    3 03 003 03 INDUSTRIAL PROCES/PRIMARY METALS   /COKE-MET BYPRODUC/ OVEN PUSHING      /TONS COAL CHARGED
402    3 03 003 04 INDUSTRIAL PROCES/PRIMARY METALS   /COKE-MET BYPRODUC/ QUENCHING         /TONS COAL CHARGED
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403    3 03 003 05 INDUSTRIAL PROCES/PRIMARY METALS   /COKE-MET BYPRODUC/ UNLOADING           /TONS COAL CHARGED
404    3 03 003 06 INDUSTRIAL PROCES/PRIMARY METALS   /COKE-MET BYPRODUC/ UNDERFIRING         /TONS COAL CHARGED
405    3 03 003 99 INDUSTRIAL PROCES/PRIMARY METALS   /COKE-MET BYPRODUC/ OTHER/NOT CLASFD    /TONS COAL CHARGED
406    3 03 004 01 INDUSTRIAL PROCES/PRIMARY METALS   /COKE MET-BEEHIVE / GENERAL             /TONS COAL CHARGED
407    3 03 005 01 INDUSTRIAL PROCES/PRIMARY METALS   /COPPER SMELTER   / TOTAL/GENERAL       /TONS CONCENTRATED ORE
408    3 03 005 02 INDUSTRIAL PROCES/PRIMARY METALS   /COPPER SMELTER   / ROASTING            /TONS CONCENTRATED ORE
409    3 03 005 03 INDUSTRIAL PROCES/PRIMARY METALS   /COPPER SMELTER   / SMELTING            /TONS CONCENTRATED ORE
410    3 03 005 04 INDUSTRIAL PROCES/PRIMARY METALS   /COPPER SMELTER   / CONVERTING          /TONS CONCENTRATED ORE
411    3 03 005 05 INDUSTRIAL PROCES/PRIMARY METALS   /COPPER SMELTER   / REFINING            /TONS CONCENTRATED ORE
412    3 03 005 06 INDUSTRIAL PROCES/PRIMARY METALS   /COPPER MINE      / ORE DRYER           /TONS OF ORE
413    3 03 005 99 INDUSTRIAL PROCES/PRIMARY METALS   /COPPER SMELTER   / OTHER/NOT CLASFD    /TONS CONCENTRATED ORE
414    3 03 006 01 INDUSTRIAL PROCES/PRIMARY METALS   /FERALLOY OPEN FNC/ 50% FESI            /TONS PRODUCED
415    3 03 006 02 INDUSTRIAL PROCES/PRIMARY METALS   /FERALLOY OPEN FNC/ 75% FESI            /TONS PRODUCED
416    3 03 006 03 INDUSTRIAL PROCES/PRIMARY METALS   /FERALLOY OPEN FNC/ 90% FESI            /TONS PRODUCED
417    3 03 006 04 INDUSTRIAL PROCES/PRIMARY METALS   /FERALLOY OPEN FNC/ SILICON METAL       /TONS PRODUCED
418    3 03 006 05 INDUSTRIAL PROCES/PRIMARY METALS   /FERALLOY OPEN FNC/ SILICOMANGANESE     /TONS PRODUCED
419    3 03 006 10 INDUSTRIAL PROCES/PRIMARY METALS   /FERROALLOY       / SCREENING           /TONS PROCESSED
420    3 03 006 11 INDUSTRIAL PROCES/PRIMARY METALS   /FERROALLOY       / ORE DRYER           /TONS PROCESSED
421    3 03 006 12 INDUSTRIAL PROCES/PRIMARY METALS   /FERROALLOY       / LO*CARB CR-REACTR   /TONS PROCESSED
422    3 03 006 99 INDUSTRIAL PROCES/PRIMARY METALS   /FERROALLOY       / OTHER/NOT CLASFD    /TONS PRODUCED
423    3 03 007 01 INDUSTRIAL PROCES/PRIMARY METALS   /FERALOY SEMCOVFNC/ FEROMANGANESE       /TONS PRODUCED
424    3 03 007 02 INDUSTRIAL PROCES/PRIMARY METALS   /FERALOY COVD FNC / GENERAL             /TONS PRODUCED
425    3 03 008 01 INDUSTRIAL PROCES/PRIMARY METALS   /IRON PRODUCTION  / BLAST FNC-ORECHG    /TONS PRODUCED
426    3 03 008 02 INDUSTRIAL PROCES/PRIMARY METALS   /IRON PRODUCTION  / BLAST FNC-AGLCHG    /TONS PRODUCED
427    3 03 008 03 INDUSTRIAL PROCES/PRIMARY METALS   /IRON PRODUCTION  / SINTERING GENERAL   /TONS PRODUCED
428    3 03 008 04 INDUSTRIAL PROCES/PRIMARY METALS   /IRON PRODUCTION  / ORE-CRUSH/HANDLE    /TONS OF ORE
429    3 03 008 05 INDUSTRIAL PROCES/PRIMARY METALS   /IRON PRODUCTION  / SCARFING            /TONS PROCESSED
430    3 03 008 06 INDUSTRIAL PROCES/PRIMARY METALS   /IRON PRODUCTION  / SAND HANDLING OPN   /TONS HANDLED
431    3 03 008 07 INDUSTRIAL PROCES/PRIMARY METALS   /IRON PRODUCTION  / MOLD OVENS          /TONS SAND BAKED
432    3 03 008 99 INDUSTRIAL PROCES/PRIMARY METALS   /IRON PRODUCTION  / OTHER/NOT CLASFD    /TONS PRODUCED
433    3 03 009 01 INDUSTRIAL PROCES/PRIMARY METALS   /STEEL PRODUCTION / OPNHEARTH BALANCE   /TONS PRODUCED
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434    3 03 009 02 INDUSTRIAL PROCES/PRIMARY METALS   /STEEL PRODUCTION / OPNHEARTH NOXLNCE /TONS PRODUCED
435    3 03 009 03 INDUSTRIAL PROCES/PRIMARY METALS   /STEEL PRODUCTION / BOF-GENERAL       /TONS PRODUCED
436    3 03 009 04 INDUSTRIAL PROCES/PRIMARY METALS   /STEEL PRODUCTION / ELECT ARC W/LANCE /TONS PRODUCED
437    3 03 009 05 INDUSTRIAL PROCES/PRIMARY METALS   /STEEL PRODUCTION / ELECT ARC NOLANCE /TONS PRODUCED
438    3 03 009 99 INDUSTRIAL PROCES/PRIMARY METALS   /STEEL PRODUCTION / OTHER/NOT CLASFD  /TONS PRODUCED
439    3 03 010 01 INDUSTRIAL PROCES/PRIMARY METALS   /LEAD SMELTERS    / SINTER/CRUSHING   /TONS CONCENTRATED ORE
440    3 03 010 02 INDUSTRIAL PROCES/PRIMARY METALS   /LEAD SMELTERS    / BLAST FURNACE     /TONS CONCENTRATED ORE
441    3 03 010 03 INDUSTRIAL PROCES/PRIMARY METALS   /LEAD SMELTERS    / REVERB FURNACE    /TONS CONCENTRATED ORE
442    3 03 010 99 INDUSTRIAL PROCES/PRIMARY METALS   /LEAD SMELTERS    / OTHER/NOT CLASFD  /TONS CONCENTRATED ORE
443    3 03 011 01 INDUSTRIAL PROCES/PRIMARY METALS   /MOLYBNUM MINING  / GENERAL           /HUNDREDS OF TONS MINED
444    3 03 011 02 INDUSTRIAL PROCES/PRIMARY METALS   /MOLYBNUM MILLING / GENERAL           /TONS PRODUCT
445    3 03 011 99 INDUSTRIAL PROCES/PRIMARY METALS   /MOLYBNUM PROCES  / OTHER/NOT CLASIFD /TONS PROCESSED
446    3 03 012 01 INDUSTRIAL PROCES/PRIMARY METALS   /TITANIUM PROCESS / CHLORINATION STAT /TONS PRODUCT
447    3 03 012 99 INDUSTRIAL PROCES/PRIMARY METALS   /TITANIUM PROCES  / OTHER/NOT CLASIFD /TONS PROCESSED
448    3 03 013 01 INDUSTRIAL PROCES/PRIMARY METALS   /GOLD             / MINING/PROCESSING /TONS ORE
449    3 03 014 01 INDUSTRIAL PROCES/PRIMARY METALS   /BARIUM           / ORE GRIND         /TONS PROCESSED
450    3 03 014 02 INDUSTRIAL PROCES/PRIMARY METALS   /BARIUM           / REDUCTN KILN      /TONS PROCESSED
451    3 03 014 03 INDUSTRIAL PROCES/PRIMARY METALS   /BARIUM           / DRIERS/CALCINERS  /TONS PROCESSED
452    3 03 014 99 INDUSTRIAL PROCES/PRIMARY METALS   /BARIUM           / OTHER/NOT CLASFD  /TONS PROCESSED
453    3 03 030 01 INDUSTRIAL PROCES/PRIMARY METALS   /ZINC SMELTING    / GENERAL           /TONS PROCESSED
454    3 03 030 02 INDUSTRIAL PROCES/PRIMARY METALS   /ZINC SMELTING    / ROASTNG/MULT-HRTH /TONS PROCESSED
455    3 03 030 03 INDUSTRIAL PROCES/PRIMARY METALS   /ZINC SMELTING    / SINTERING         /TONS PROCESSED
456    3 03 030 04 INDUSTRIAL PROCES/PRIMARY METALS   /ZINC SMELTING    / HORIZ RETORTS     /TONS PROCESSED
457    3 03 030 05 INDUSTRIAL PROCES/PRIMARY METALS   /ZINC SMELTING    / VERT RETORTS      /TONS PROCESSED
458    3 03 030 06 INDUSTRIAL PROCES/PRIMARY METALS   /ZINC SMELTING    / ELECTROLYTIC PROC /TONS PROCESSED
459    3 03 030 99 INDUSTRIAL PROCES/PRIMARY METALS   /ZINC SMELTING    / OTHER/NOT CLASFD  /TONS PROCESSED
460    3 03 999 99 INDUSTRIAL PROCES/PRIMARY METALS   /OTHER/NOT CLASFD / SPECIFY IN REMARK /TONS PRODUCED
461    3 04 001 01 INDUSTRIAL PROCES/SECONDARY METALS /ALUMINUM OPERATN / SWEATINGFURNACE   /TONS PRODUCED
462    3 04 001 02 INDUSTRIAL PROCES/SECONDARY METALS /ALUMINUM OPERATN / SMELT-CRUCIBLE    /TONS METAL PRODUCED
463    3 04 001 03 INDUSTRIAL PROCES/SECONDARY METALS /ALUMINUM OPERATN / SMELT-REVERB FNC  /TONS METAL PRODUCED
464    3 04 001 04 INDUSTRIAL PROCES/SECONDARY METALS /ALUMINUM OPERATN / CHLORINATN STATN  /TONS METAL PRODUCED
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465   3 04 001 10 INDUSTRIAL PROCES/SECONDARY METALS /ALUMINUM OPERATN / FOIL ROLLING       /TONS PRODUCT
466   3 04 001 11 INDUSTRIAL PROCES/SECONDARY METALS /ALUMINUM OPERATN / FOIL CONVERTING    /TONS PRODUCED
467   3 04 001 20 INDUSTRIAL PROCES/SECONDARY METALS /ALUMINUM OPERATN / CAN MANUFACTURE    /TONS PRODUCED
468   3 04 001 50 INDUSTRIAL PROCES/SECONDARY METALS /ALUMINUM OPERATN / ROLL-DRAW-EXTRUDE  /TONS PRODUCED
469   3 04 001 99 INDUSTRIAL PROCES/SECONDARY METALS /ALUMINUM OPERATN / OTHER/NOT CLASFD   /TONS PRODUCED
470   3 04 002 01 INDUSTRIAL PROCES/SECONDARY METALS /BRASS/BRONZ MELT / BLAST FNC          /TONS CHARGE
471   3 04 002 02 INDUSTRIAL PROCES/SECONDARY METALS /BRASS/BRONZ MELT / CRUCIBLE FNC       /TONS CHARGE
472   3 04 002 03 INDUSTRIAL PROCES/SECONDARY METALS /BRASS/BRONZ MELT / CUPOLA FNC         /TONS CHARGE
473   3 04 002 04 INDUSTRIAL PROCES/SECONDARY METALS /BRASS/BRONZ MELT / ELECT INDUCTION    /TONS CHARGE
474   3 04 002 05 INDUSTRIAL PROCES/SECONDARY METALS /BRASS/BRONZ MELT / REVERB FNC         /TONS CHARGE
475   3 04 002 06 INDUSTRIAL PROCES/SECONDARY METALS /BRASS/BRONZ MELT / ROTARY FNC         /TONS CHARGE
476   3 04 002 99 INDUSTRIAL PROCES/SECONDARY METALS /BRASS/BRONZ MELT / OTHER/NOT CLASIFD  /TONS PRODUCED
477   3 04 003 01 INDUSTRIAL PROCES/SECONDARY METALS /GRAY IRON        / CUPOLA             /TONS METAL CHARGE
478   3 04 003 02 INDUSTRIAL PROCES/SECONDARY METALS /GRAY IRON        / REVERB FNC         /TONS METAL CHARGE
479   3 04 003 03 INDUSTRIAL PROCES/SECONDARY METALS /GRAY IRON        / ELECT INDUCTION    /TONS METAL CHARGE
480   3 04 003 05 INDUSTRIAL PROCES/SECONDARY METALS /GRAY IRON        / ANNEALING OPERATN  /TONS METAL CHARGE
481   3 04 003 30 INDUSTRIAL PROCES/SECONDARY METALS /GRAY IRON        / MISC CAST-FABCTN   /TONS PROCESSED
482   3 04 003 40 INDUSTRIAL PROCES/SECONDARY METALS /GRAY IRON        / GRINDING-CLEANING  /TONS PROCESSED
483   3 04 003 99 INDUSTRIAL PROCES/SECONDARY METALS /GRAY IRON        / OTHER/NOT CLASIFD  /TONS METAL CHARGE
484   3 04 004 01 INDUSTRIAL PROCES/SECONDARY METALS /LEAD SMELT SEC   / POT FURNACE        /TONS PROCESSED
485   3 04 004 02 INDUSTRIAL PROCES/SECONDARY METALS /LEAD SMELT SEC   / REVERB FNC         /TONS PROCESSED
486   3 04 004 03 INDUSTRIAL PROCES/SECONDARY METALS /LEAD SMELT SEC   / BLAST/CUPOLA FNC   /TONS PROCESSED
487   3 04 004 04 INDUSTRIAL PROCES/SECONDARY METALS /LEAD SMELT SEC   / ROTARY REVERB FNC  /TONS PROCESSED
488   3 04 004 08 INDUSTRIAL PROCES/SECONDARY METALS /LEAD SMELT SEC   / LEAD OXIDE MFG     /TONS PROCESSED
489   3 04 004 99 INDUSTRIAL PROCES/SECONDARY METALS /LEAD SMELT SEC   / OTHER/NOT CLASIFD  /TONS PROCESSED
490   3 04 005 01 INDUSTRIAL PROCES/SECONDARY METALS /LEAD BATTERY     / GENERAL            /TONS PROCESSED
491   3 04 005 99 INDUSTRIAL PROCES/SECONDARY METALS /LEAD BATTERY     / OTHER/NOT CLASIFD  /TONS PROCESSED
492   3 04 006 01 INDUSTRIAL PROCES/SECONDARY METALS /MAGNESIUM SEC    / POT FURNACE        /TONS PROCESSED
493   3 04 006 99 INDUSTRIAL PROCES/SECONDARY METALS /MAGNESIUM SEC    / OTHER/NOT CLASIFD  /TONS PROCESSED
494   3 04 007 01 INDUSTRIAL PROCES/SECONDARY METALS /STEEL FOUNDRY    / ELECTRIC ARC FNC   /TONS PROCESSED
495   3 04 007 02 INDUSTRIAL PROCES/SECONDARY METALS /STEEL FOUNDRY    / OPEN HEARTH FNC    /TONS PROCESSED
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496   3 04 007 03 INDUSTRIAL PROCES/SECONDARY METALS /STEEL FOUNDRY    / OPEN HEARTH LANCD /TONS PROCESSED
497   3 04 007 04 INDUSTRIAL PROCES/SECONDARY METALS /STEEL FOUNDRY    / HEAT-TREAT FNC    /TONS PROCESSED
498   3 04 007 05 INDUSTRIAL PROCES/SECONDARY METALS /STEEL FOUNDRY    / INDUCTION FURNACE /TONS PROCESSED
499   3 04 007 99 INDUSTRIAL PROCES/SECONDARY METALS /STEEL FOUNDRY    / OTHER/NOT CLASIFD /TONS PROCESSED
500   3 04 008 01 INDUSTRIAL PROCES/SECONDARY METALS /ZINC SEC         / RETORT FNC        /TONS PRODUCED
501   3 04 008 02 INDUSTRIAL PROCES/SECONDARY METALS /ZINC SEC         / HORIZ MUFFLE FNC  /TONS PRODUCED
502   3 04 008 03 INDUSTRIAL PROCES/SECONDARY METALS /ZINC SEC         / POT FURNACE       /TONS PRODUCED
503   3 04 008 04 INDUSTRIAL PROCES/SECONDARY METALS /ZINC SEC         / KETTLE-SWEAT FNC  /TONS PRODUCED
504   3 04 008 05 INDUSTRIAL PROCES/SECONDARY METALS /ZINC SEC         / GALVANIZING KETTL /TONS PRODUCED
505   3 04 008 06 INDUSTRIAL PROCES/SECONDARY METALS /ZINC SEC         / CALCINING KILN    /TONS PRODUCED
506   3 04 008 07 INDUSTRIAL PROCES/SECONDARY METALS /ZINC SEC         / CONCENTRATE DRYER /TONS PROCESSED
507   3 04 008 08 INDUSTRIAL PROCES/SECONDARY METALS /ZINC SEC         / REVERB-SWEAT FNC  /TONS PRODUCED
508   3 04 008 99 INDUSTRIAL PROCES/SECONDARY METALS /ZINC SEC         / OTHER/NOT CLASIFD /TONS PROCESSED
509   3 04 009 01 INDUSTRIAL PROCES/SECONDARY METALS /MALLEABLE IRON   / ANNEALING OPERATN /TONS METAL CHARGE
510   3 04 009 99 INDUSTRIAL PROCES/SECONDARY METALS /MALLEABLE IRON   / OTHER/NOT CLASIFD /TONS METAL CHARGE
511   3 04 010 01 INDUSTRIAL PROCES/SECONDARY METALS /NICKEL           / FLUX FURNACE      /TONS PROCESSED
512   3 04 010 99 INDUSTRIAL PROCES/SECONDARY METALS /NICKEL           / OTHER/NOT CLASIFD /TONS PROCESSED
513   3 04 011 01 INDUSTRIAL PROCES/SECONDARY METALS /ZIRCONIUM        / OXIDE KILN        /TONS PROCESSED
514   3 04 011 99 INDUSTRIAL PROCES/SECONDARY METALS /ZIRCONIUM        / OTHER/NOT CLASIFD /TONS PROCESSED
515   3 04 020 01 INDUSTRIAL PROCES/SECONDARY METALS /FURNACE ELECTRODE/ CALCINATION       /TONS PROCESSED
516   3 04 020 02 INDUSTRIAL PROCES/SECONDARY METALS /FURNACE ELECTRODE/ MIXING            /TONS PROCESSED
517   3 04 020 03 INDUSTRIAL PROCES/SECONDARY METALS /FURNACE ELECTRODE/ PITCH TREATING    /TONS PROCESSED
518   3 04 020 04 INDUSTRIAL PROCES/SECONDARY METALS /FURNACE ELECTRODE/ BAKE FURNACES     /TONS PROCESSED
519   3 04 020 99 INDUSTRIAL PROCES/SECONDARY METALS /FURNACE ELECTRODE/ OTHER/NOT CLASIFD /TONS PROCESSED
520   3 04 050 01 INDUSTRIAL PROCES/SECONDARY METALS /MISC CAST&FABRCTN/ SPECIFY IN REMARK /TONS PRODUCED
521   3 04 999 99 INDUSTRIAL PROCES/SECONDARY METALS /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS PROCESSED
522   3 05 001 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /ASPHALT ROOFING  / BLOWING OPERATION /TONS SATURATED FELT PRODUCED
523   3 05 001 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /ASPHALT ROOFING  / DIPPING ONLY      /TONS SATURATED FELT PRODUCED
524   3 05 001 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /ASPHALT ROOFING  / SPRAYING ONLY     /TONS SATURATED FELT PRODUCED
525   3 05 001 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /ASPHALT ROOFING  / DIPPING/SPRAYING  /TONS SATURATED FELT PRODUCED
526   3 05 001 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /ASPHALT ROOFING  / OTHER/NOT CLASIFD /TONS SATURATED FELT PRODUCED
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527    3 05 002 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /ASPHALTIC CONCRET/ ROTARY DRYER      /TONS PRODUCED
528    3 05 002 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /ASPHALTIC CONCRET/ OTHER SOURCES     /TONS PRODUCED
529    3 05 002 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /ASPHALTIC CONCRET/ OTHER/NOT CLASIFD /TONS PRODUCED
530    3 05 003 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /BRICK MANUFACTURE/ DRYING-RAW MTL    /TONS PRODUCED
531    3 05 003 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /BRICK MANUFACTURE/ GRINDING-RAW MTL  /TONS PRODUCED
532    3 05 003 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /BRICK MANUFACTURE/ STORAGE-RAW MTL   /TONS PRODUCED
533    3 05 003 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /BRICK MANUFACTURE/ CURING GAS FIRED  /TONS PRODUCED
534    3 05 003 05 INDUSTRIAL PROCES/MINERAL PRODUCTS /BRICK MANUFACTURE/ CURING OIL FIRED  /TONS PRODUCED
535    3 05 003 06 INDUSTRIAL PROCES/MINERAL PRODUCTS /BRICK MANUFACTURE/ CURING COAL FIRED /TONS PRODUCED
536    3 05 003 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /BRICK MANUFACTURE/ OTHER/NOT CLASIFD /TONS PRODUCED
537    3 05 004 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /CALCIUM CARBIDE  / ELECTRIC FNC      /TONS PRODUCED
538    3 05 004 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /CALCIUM CARBIDE  / COKE DRYER        /TONS PRODUCED
539    3 05 004 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /CALCIUM CARBIDE  / FNC ROOM VENTS    /TONS PRODUCED
540    3 05 004 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /CALCIUM CARBIDE  / OTHER/NOT CLASIFD /TONS PROCESSED
541    3 05 005 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /CASTABLE REFRACTY/ RAWMATL DRYER     /TONS FEED MATERIAL
542    3 05 005 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /CASTABLE REFRACTY/ RAWMATL CRUSH/PRC /TONS FEED MATERIAL
543    3 05 005 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /CASTABLE REFRACTY/ ELECTRIC ARC MELT /TONS FEED MATERIAL
544    3 05 005 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /CASTABLE REFRACTY/ CURING OVEN       /TONS FEED MATERIAL
545    3 05 005 05 INDUSTRIAL PROCES/MINERAL PRODUCTS /CASTABLE REFRACTY/ MOLD/SHAKEOUT     /TONS FEED MATERIAL
546    3 05 005 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /CASTABLE REFRACTY/ OTHER/NOT CLASIFD /TONS FEED MATERIAL
547    3 05 006 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG DRY   / KILNS             /BARRELS CEMENT PRODUCED
548    3 05 006 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG DRY   / DRYERS/GRINDERETC /BARRELS CEMENT PRODUCED
549    3 05 006 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG DRY   / KILNS-OIL FIRED   /TONS CEMENT PRODUCED
550    3 05 006 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG DRY   / KILNS-GAS FIRED   /TONS CEMENT PRODUCED
551    3 05 006 05 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG DRY   / KILNS-COAL FIRED  /TONS CEMENT PRODUCED
552    3 05 006 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG DRY   / OTHER/NOT CLASIFD /TONS CEMENT PRODUCED
553    3 05 007 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG WET   / KILNS             /BARRELS CEMENT PRODUCED
554    3 05 007 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG WET   / DRYERS/GRINDERETC /BARRELS CEMENT PRODUCED
555    3 05 007 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG WET   / KILNS-OIL FIRED   /TONS CEMENT PRODUCED
556    3 05 007 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG WET   / KILNS GAS FIRED   /TONS CEMENT PRODUCED
557    3 05 007 05 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG WET   / KILNS-COAL FIRED  /TONS CEMENT PRODUCED
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558    3 05 007 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /CEMENT MFG WET    / OTHER/NOT CLASIFD /TONS CEMENT PRODUCED
559    3 05 008 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /CERAMIC/CLAY MFG / DRYING            /TONS INPUT TO PROCESS
560    3 05 008 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /CERAMIC/CLAY MFG / GRINDING          /TONS INPUT TO PROCESS
561    3 05 008 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /CERAMIC/CLAY MFG / STORAGE           /TONS INPUT TO PROCESS
562    3 05 008 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /CERAMIC/CLAY MFG / OTHER/NOT CLASIFD /TONS PRODUCED
563    3 05 009 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /CLAY/FLYASHSINTER/ FLYASH            /TONS FINISHED PRODUCT
564    3 05 009 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /CLAY/FLYASHSINTER/ CLAY/COKE         /TONS FINISHED PRODUCT
565    3 05 009 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /CLAY/FLYASHSINTER/ NATURAL CLAY      /TONS FINISHED PRODUCT
566    3 05 009 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /CLAY/FLYASHSINTER/ OTHER/NOT CLASIFD /TONS PRODUCED
567    3 05 010 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /COAL CLEANING    / THERM/FLUID BED   /TONS COAL DRIED
568    3 05 010 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /COAL CLEANING    / THERM/FLASH       /TONS COAL DRIED
569    3 05 010 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /COAL CLEANING    / THERM/MULTILOUVRD /TONS COAL DRIED
570    3 05 010 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /COAL CLEANING    / OTHER/NOT CLASIFD /TONS COAL CLEANED
571    3 05 011 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /CONCRETE BATCHING/ GENERAL           /CUBIC YARDS CONCRETE PRODUCED
572    3 05 011 20 INDUSTRIAL PROCES/MINERAL PRODUCTS /CONCRETE BATCHING/ ASBEST/CEMNT PDTS /TONS PRODUCT
573    3 05 011 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /CONCRETE BATCHING/ OTHER/NOT CLASFD  /TONS PRODUCT
574    3 05 012 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /FIBERGLASS MFG   / REVERBFNC-REGENEX /TONS MATERIAL PROCESSED
575    3 05 012 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /FIBERGLASS MFG   / REVERBFNC-RECUPEX /TONS MATERIAL PROCESSED
576    3 05 012 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /FIBERGLASS MFG   / ELECTRIC IND FNC  /TONS MATERIAL PROCESSED
577    3 05 012 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /FIBERGLASS MFG   / FORMING LINE      /TONS MATERIAL PROCESSED
578    3 05 012 05 INDUSTRIAL PROCES/MINERAL PRODUCTS /FIBERGLASS MFG   / CURING OVEN       /TONS MATERIAL PROCESSED
579    3 05 012 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /FIBERGLASS MFG   / OTHER/NOT CLASIFD /TONS PROCESSED
580    3 05 013 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /FRIT MFG         / ROTARY FNC GENL   /TONS CHARGE
581    3 05 013 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /FRIT MFG         / OTHER/NOT CLASIFD /TONS CHARGED
582    3 05 014 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /GLASS MFG        / SODALIME GENL FNC /TONS GLASS PRODUCED
583    3 05 014 10 INDUSTRIAL PROCES/MINERAL PRODUCTS /GLASS MFG        / RAW MAT REC/STORG /TONS PROCESSED
584    3 05 014 11 INDUSTRIAL PROCES/MINERAL PRODUCTS /GLASS MFG        / BATCHING/MIXING   /TONS PROCESSED
585    3 05 014 12 INDUSTRIAL PROCES/MINERAL PRODUCTS /GLASS MFG        / MOLTEN HOLD TANKS /TONS PROCESSED
586    3 05 014 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /GLASS MFG        / OTHER/NOT CLASIFD /TONS PRODUCED
587    3 05 015 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /GYPSUM MFG       / RW MTL DRYER      /TONS THROUGHPUT
588    3 05 015 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /GYPSUM MFG       / PRIMARY GRINDER   /TONS THROUGHPUT
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589   3 05 015 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /GYPSUM MFG       / CALCINER          /TONS THROUGHPUT
590   3 05 015 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /GYPSUM MFG       / CONVEYING         /TONS THROUGHPUT
591   3 05 015 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /GYPSUM MFG       / OTHER/NOT CLASIFD /TONS THROUGHPUT
592   3 05 016 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /LIME MFG         / PRIMARY CRUSHING  /TONS PROCESSED
593   3 05 016 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /LIME MFG         / SECNDRY CRUSHING  /TONS PROCESSED
594   3 05 016 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /LIME MFG         / CALCINNG-VERTKILN /TONS PROCESSED
595   3 05 016 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /LIME MFG         / CALCINNG-ROTYKILN /TONS PROCESSED
596   3 05 016 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /LIME MFG         / OTHER/NOT CLASIFD /TONS PROCESSED
597   3 05 017 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /MINERAL WOOL     / CUPOLA            /TONS CHARGE
598   3 05 017 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /MINERAL WOOL     / REVERB FNC        /TONS CHARGE
599   3 05 017 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /MINERAL WOOL     / BLOW CHAMBER      /TONS CHARGE
600   3 05 017 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /MINERAL WOOL     / CURING OVEN       /TONS CHARGE
601   3 05 017 05 INDUSTRIAL PROCES/MINERAL PRODUCTS /MINERAL WOOL     / COOLER            /TONS CHARGE
602   3 05 017 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /MINERAL WOOL     / OTHER/NOT CLASIFD /TONS PROCESSED
603   3 05 018 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /PERLITE MFG      / VERTICAL FNC GEN  /TONS CHARGE
604   3 05 018 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /PERLITE MFG      / OTHER/NOT CLASIFD /TONS PROCESSED
605   3 05 019 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /PHOSPHATE ROCK   / DRYING            /TONS PHOSPHATE ROCK
606   3 05 019 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /PHOSPHATE ROCK   / GRINDING          /TONS PHOSPHATE ROCK
607   3 05 019 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /PHOSPHATE ROCK   / TRANSFER/STORAGE  /TONS PHOSPHATE ROCK
608   3 05 019 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /PHOSPHATE ROCK   / OPEN STORAGE      /TONS PHOSPHATE ROCK
609   3 05 019 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /PHOSPHATE ROCK   / OTHER/NOT CLASIFD /TONS PROCESSED
610   3 05 020 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /STONE QUARY/PROC / PRIMARY CRUSHING  /TONS RAW MATERIAL
611   3 05 020 02 INDUSTRIAL PROCES/MINERAL PRODUCTS /STONE QUARY/PROC / SEC CRUSH/SCREEN  /TONS RAW MATERIAL
612   3 05 020 03 INDUSTRIAL PROCES/MINERAL PRODUCTS /STONE QUARY/PROC / TERT CRUSH/SCREEN /TONS RAW MATERIAL
613   3 05 020 04 INDUSTRIAL PROCES/MINERAL PRODUCTS /STONE QUARY/PROC / RECRUSH/SCREENING /TONS RAW MATERIAL
614   3 05 020 05 INDUSTRIAL PROCES/MINERAL PRODUCTS /STONE QUARY/PROC / FINES MILL        /TONS RAW MATERIAL
615   3 05 020 06 INDUSTRIAL PROCES/MINERAL PRODUCTS /STONE QUARY/PROC / SCREEN/CONVY/HNDL /TONS PRODUCT
616   3 05 020 07 INDUSTRIAL PROCES/MINERAL PRODUCTS /STONE QUARY/PROC / OPEN STORAGE      /TONS PRODUCT STORED
617   3 05 020 08 INDUSTRIAL PROCES/MINERAL PRODUCTS /STONE QUARY/PROC / CUT STONE-GENERAL /TONS PROCESSED
618   3 05 020 09 INDUSTRIAL PROCES/MINERAL PRODUCTS /STONE QUARY/PROC / BLASTING-GENERAL  /TONS PROCESSED
619   3 05 020 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /STONE QUARY/PROC / OTHER/NOT CLASIFD /TONS PROCESSED
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620   3 05 021 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /SALT MINING      / GENERAL            /TONS MINED
621   3 05 022 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /POTASH PRODUCTION/ MINE-GRIND/DRY     /TONS ORE
622   3 05 022 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /POTASH PRODUCTION/ OTHER/NOT CLASIFD /TONS PROCESSED
623   3 05 023 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /CALCIUM BORATE   / MINING/PROCESSING /TONS PRODUCT
624   3 05 023 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /CALCIUM BORATE   / OTHER/NOT CLASIFD /TONS PROCESSED
625   3 05 024 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /MG CARBONATE     / MINE/PROCESS      /TONS PRODUCT
626   3 05 024 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /MG CARBONATE     / OTHER/NOT CLASIFD /TONS PROCESSED
627   3 05 025 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /SAND/GRAVEL      / CRUSHING/SCREENIN /TONS PRODUCT
628   3 05 025 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /SAND/GRAVEL      / OTHER/NOT CLASIFD /TONS PROCESSED
629   3 05 026 01 INDUSTRIAL PROCES/MINERAL PRODUCTS /DIATOMACOUSEARTH / HANDLING           /TONS PRODUCT
630   3 05 026 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /DIATOMACOUS EARTH/ OTHER/NOT CLASIFD /TONS PROCESSED
631   3 05 030 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /CERAMIC ELECT PTS/ OTHER/NOT CLASIFD /TONS PROCESSED
632   3 05 999 99 INDUSTRIAL PROCES/MINERAL PRODUCTS /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS PRODUCT
633   3 06 001 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /PROCESS HEATER   / OIL                /1000 BARRELS OIL BURNED
634   3 06 001 02 INDUSTRIAL PROCES/PETROLEUM INDRY  /PROCESS HEATER   / GAS                /1000 CUBIC FEET GAS BURNED
635   3 06 001 03 INDUSTRIAL PROCES/PETROLEUM INDRY  /PROCESS HEATER   / OIL                /1000 GALLONS OIL BURNED
636   3 06 001 04 INDUSTRIAL PROCES/PETROLEUM INDRY  /PROCESS HEATER   / GAS                /MILLION CUBIC FEET BURNED
637   3 06 002 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /FLUID CRACKERS   / GENERAL  (FCC)     /1000 BARRELS FRESH FEED
638   3 06 003 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /MOV-BED CAT-CRACK/ GENERAL  (TCC)     /1000 BARRELS FRESH FEED
639   3 06 004 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /BLOW-DOWN SYSTM  / W/CONTROLS         /1000 BARRELS REFINERY CAPACITY
640   3 06 004 02 INDUSTRIAL PROCES/PETROLEUM INDRY  /BLOW-DOWN SYSTM  / W/O CONTROLS       /1000 BARRELS REFINERY CAPACITY
641   3 06 005 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /PROCESS DRAINS   / GEN W/CONTROL      /1000 BARRELS WASTE WATER
642   3 06 005 02 INDUSTRIAL PROCES/PETROLEUM INDRY  /PROCESS DRAINS   / GEN W/O CONTROL    /1000 BARRELS WASTE WATER
643   3 06 006 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /VACUUM JETS      / W/CONTROL          /1000 BARRELS VACUUM DISTILLATION
644   3 06 006 02 INDUSTRIAL PROCES/PETROLEUM INDRY  /VACUUM JETS      / W/O CONTROL        /1000 BARRELS VACUUM DISTILLATION
645   3 06 007 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /COOLING TOWERS   /                    /MILLION GALLONS COOLING WATER
646   3 06 008 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /MISCELLANEOUS    / PIPE/VALVE-FLANGE /1000 BARRELS REFINERY CAPACITY
647   3 06 008 02 INDUSTRIAL PROCES/PETROLEUM INDRY  /MISCELLANEOUS    / VESL RELIEF VALVE /1000 BARRELS REFINERY CAPACITY
648   3 06 008 03 INDUSTRIAL PROCES/PETROLEUM INDRY  /MISCELLANEOUS    / PUMP SEALS         /1000 BARRELS REFINERY CAPACITY
649   3 06 008 04 INDUSTRIAL PROCES/PETROLEUM INDRY  /MISCELLANEOUS    / COMPRESR SEALS     /1000 BARRELS REFINERY CAPACITY
650   3 06 008 05 INDUSTRIAL PROCES/PETROLEUM INDRY  /MISCELLANEOUS    / OTHER-GENL         /1000 BARRELS REFINERY CAPACITY
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651   3 06 009 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /FLARES            / NATURAL GAS       /MILLIONS OF CUBIC FEET
652   3 06 009 99 INDUSTRIAL PROCES/PETROLEUM INDRY  /FLARES            / OTHER/NOT CLASIFD /MILLIONS OF CUBIC FEET
653   3 06 010 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /SLUDGE CONVERTER  / GENERAL           /TONS PROCESSED
654   3 06 011 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /ASPHALT OXIDIZER  / GENERAL           /TONS PROCESSED
655   3 06 011 99 INDUSTRIAL PROCES/PETROLEUM INDRY  /ASPHALT OXIDIZER  / OTHER/NOT CLASIFD /TONS PROCESSED
656   3 06 012 01 INDUSTRIAL PROCES/PETROLEUM INDRY  /FLUID COKING      / GENERAL           /1000 BARRELS FRESH FEED
657   3 06 999 98 INDUSTRIAL PROCES/PETROLEUM INDRY  /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS PROCESSED
658   3 06 999 99 INDUSTRIAL PROCES/PETROLEUM INDRY  /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /BARRELS-PROCESSED
659   3 07 001 01 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / BLOWTNK ACCUMULTR /AIR-DRY TONS UNBLEACHED PULP
660   3 07 001 02 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / WASHRS/SCREENS    /AIR-DRY TONS UNBLEACHED PULP
661   3 07 001 03 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / MULT-EFFECT EVAP  /AIR-DRY TONS UNBLEACHED PULP
662   3 07 001 04 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / RECVY BOLR/DCEVAP /AIR-DRY TONS UNBLEACHED PULP
663   3 07 001 05 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / SMELT DISSOLV TNK /AIR-DRY TONS UNBLEACHED PULP
664   3 07 001 06 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / LIME KILNS        /AIR-DRY TONS UNBLEACHED PULP
665   3 07 001 07 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / TURPENTINE CONDSR /AIR-DRY TONS UNBLEACHED PULP
666   3 07 001 08 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / FLUIDIZED CALCINER /AIR-DRY TONS UNBLEACHED PULP
667   3 07 001 09 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / LIQUOR OXIDN TOWR /AIR-DRY TONS UNBLEACHED PULP
668   3 07 001 99 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / OTHER/NOT CLASIFD /AIR-DRY TONS UNBLEACHED PULP
669   3 07 002 01 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / LIQUOR RECOVERY   /AIR-DRY TONS UNBLEACHED PULP
670   3 07 002 02 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / SULFITE TOWER     /AIR-DRY TONS UNBLEACHED PULP
671   3 07 002 03 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / DIGESTER          /AIR-DRY TONS UNBLEACHED PULP
672   3 07 002 04 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / SMELT TANK        /AIR-DRY TONS UNBLEACHED PULP
673   3 07 002 05 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / EVAPORATORS       /AIR-DRY TONS UNBLEACHED PULP
674   3 07 002 06 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / PULP DIGESTER     /TONS AIR DRY PULP
675   3 07 002 99 INDUSTRIAL PROCES/WOOD PRODUCTS    /SULFATE PULPNG    / OTHER/NOT CLASIFD /TONS AIR DRY PULP
676   3 07 004 01 INDUSTRIAL PROCES/WOOD PRODUCTS    /PULPBOARD MFG     / PAPERBOARD-GEN    /TONS FINISHED PRODUCT
677   3 07 004 02 INDUSTRIAL PROCES/WOOD PRODUCTS    /PULPBOARD MFG     / FIBERBOARD-GEN    /TONS FINISHED PRODUCT
678   3 07 004 99 INDUSTRIAL PROCES/WOOD PRODUCTS    /PULPBOARD MFG     / OTHER/NOT CLASIFD /TONS FINISHED PRODUCT
679   3 07 005 01 INDUSTRIAL PROCES/WOOD PRODUCTS    /PRESSURE TREATING/ CREOSOTE          /TONS OF WOOD TREATED
680   3 07 005 99 INDUSTRIAL PROCES/WOOD PRODUCTS    /PRESSURE TREATING/ OTHER/NOT CLASIFD /TONS OF WOOD TREATED
681   3 07 006 01 INDUSTRIAL PROCES/WOOD PRODUCTS    /TALLOIL/ROSIN     / GENERAL           /TONS OF PRODUCT
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682   3 07 007 02 INDUSTRIAL PROCES/WOOD PRODUCTS    /PLYWOOD/PARTBOARD/ VENEER DRYER       /TONS PROCESSED
683   3 07 007 01 INDUSTRIAL PROCES/WOOD PRODUCTS    /PLYWOOD/PARTBOARD/ SANDING            /TONS PROCESSED
684   3 07 007 99 INDUSTRIAL PROCES/WOOD PRODUCTS    /PLYWOOD/PARTBOARD/ OTHER/NOT CLASIFD /TONS PROCESSED
685   3 07 008 99 INDUSTRIAL PROCES/WOOD PRODUCTS    /SAWMILL OPERATNS / OTHER/NOT CLASIFD /TONS PROCESSED
686   3 07 009 99 INDUSTRIAL PROCES/WOOD PRODUCTS    /EXCELSIOR MFG    / OTHER/NOT CLASIFD /TONS PROCESSED
687   3 07 010 99 INDUSTRIAL PROCES/WOOD PRODUCTS    /CORK PROCESSING  / OTHER/NOT CLASIFD /TONS PROCESSED
688   3 07 020 99 INDUSTRIAL PROCES/WOOD PRODUCTS    /FURNITURE MFG    / OTHER/NOT CLASIFD /TONS PROCESSED
689   3 07 999 99 INDUSTRIAL PROCES/WOOD PRODUCTS    /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS PROCESSED
690   3 09 001 01 INDUSTRIAL PROCES/METAL FABRICATION/IRON/STEEL       / MISC HARDWARE     /TONS OF PRODUCT
691   3 09 001 02 INDUSTRIAL PROCES/METAL FABRICATION/IRON/STEEL       / FARM MACHINERY    /TONS OF PRODUCT
692   3 09 001 99 INDUSTRIAL PROCES/METAL FABRICATION/IRON/STEEL       / OTHER/NOT CLASIFD /TONS PROCESSED
693   3 09 010 99 INDUSTRIAL PROCES/METAL FABRICATION/PLATING OPERATONS/ OTHER/NOT CLASIFD. /TONS PLATED
694   3 09 020 99 INDUSTRIAL PROCES/METAL FABRICATION/CAN MAKING OPRNS / OTHER/NOT CLASIFD /TONS PRODUCT
695   3 09 999 99 INDUSTRIAL PROCES/METAL FABRICATION/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS PROCESSED
696   3 20 999 99 INDUSTRIAL PROCES/LEATHER PRODUCTS /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS PROCESSED
697   3 30 001 01 INDUSTRIAL PROCES/TEXTILE MFG      /GENERAL FABRICS  / YARN PREP/BLEACH  /TONS PROCESSED
698   3 30 001 99 INDUSTRIAL PROCES/TEXTILE MFG      /GENERAL FABRICS  / OTHER/NOT SPECIFD /TONS PROCESSED
699   3 30 002 99 INDUSTRIAL PROCES/TEXTILE MFG      /RUBBERIZED FABRICS/ OTHER/NOT SPECIFD /TONS PROCESSED
700   3 30 003 99 INDUSTRIAL PROCES/TEXTILE MFG      /CARPET OPERATNS  / OTHER/NOT SPECIFD /TONS PROCESSED
701   3 90 001 99 INDUSTRIAL PROCES/INPROCESS FUEL   /ANTHRACITE COAL  / OTHER/NOT CLASIFD /TONS BURNED
702   3 90 002 01 INDUSTRIAL PROCES/INPROCESS FUEL   /BITUMINOUS COAL  / CEMENT KILN       /TONS BURNED
703   3 90 002 06 INDUSTRIAL PROCES/INPROCESS FUEL   /BITUMINOUS COAL  / BRICK KILN/DRY    /TONS BURNED
704   3 90 002 07 INDUSTRIAL PROCES/INPROCESS FUEL   /BITUMINOUS COAL  / GYPSUM KILN/ETC   /TONS BURNED
705   3 90 002 08 INDUSTRIAL PROCES/INPROCESS FUEL   /BITUMINOUS COAL  / COAL DRYERS       /TONS BURNED
706   3 90 002 99 INDUSTRIAL PROCES/INPROCESS FUEL   /BITUMINOUS COAL  / OTHER/NOT CLASIFD /TONS BURNED
707   3 90 004 01 INDUSTRIAL PROCES/INPROCESS FUEL   /RESIDUAL OIL     / ASPHALT DRYER     /1000 GALLONS BURNED
708   3 90 004 02 INDUSTRIAL PROCES/INPROCESS FUEL   /RESIDUAL OIL     / CEMENT KILN       /1000 GALLONS BURNED
709   3 90 004 03 INDUSTRIAL PROCES/INPROCESS FUEL   /RESIDUAL OIL     / LIME KILN         /1000 GALLONS BURNED
710   3 90 004 04 INDUSTRIAL PROCES/INPROCESS FUEL   /RESIDUAL OIL     / KAOLIN KILN       /1000 GALLONS BURNED
711   3 90 004 05 INDUSTRIAL PROCES/INPROCESS FUEL   /RESIDUAL OIL     / METAL MELTING     /1000 GALLONS BURNED
712   3 90 004 06 INDUSTRIAL PROCES/INPROCESS FUEL   /RESIDUAL OIL     / BRICK KILN/DRY    /1000 GALLONS BURNED
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713   3 90 004 07 INDUSTRIAL PROCES/INPROCESS FUEL   /RESIDUAL OIL      / GYPSUM KILN/ETC    /1000 GALLONS BURNED
714   3 90 004 99 INDUSTRIAL PROCES/INPROCESS FUEL   /RESIDUAL OIL      / OTHER/NOT CLASIFD  /1000 GALLONS BURNED
715   3 90 005 01 INDUSTRIAL PROCES/INPROCESS FUEL   /DISTILLATE OIL    / ASPHALT DRYER      /1000 GALLONS BURNED
716   3 90 005 02 INDUSTRIAL PROCES/INPROCESS FUEL   /DISTILLATE OIL    / CEMENT KILN        /1000 GALLONS BURNED
717   3 90 005 03 INDUSTRIAL PROCES/INPROCESS FUEL   /DISTILLATE OIL    / LIME KILN          /1000 GALLONS BURNED
718   3 90 005 04 INDUSTRIAL PROCES/INPROCESS FUEL   /DISTILLATE OIL    / KAOLIN KILN        /1000 GALLONS BURNED
719   3 90 005 05 INDUSTRIAL PROCES/INPROCESS FUEL   /DISTILLATE OIL    / METAL MELTING      /1000 GALLONS BURNED
720   3 90 005 06 INDUSTRIAL PROCES/INPROCESS FUEL   /DISTILLATE OIL    / BRICK KILN/DRY     /1000 GALLONS BURNED
721   3 90 005 07 INDUSTRIAL PROCES/INPROCESS FUEL   /DISTILLATE OIL    / GYPSUM KILN/ETC    /1000 GALLONS BURNED
7 2   3 90 005 99 INDUSTRIAL PROCES/INPROCESS FUEL   /DISTILLATE OIL    / OTHER/NOT CLASIFD  /1000 GALLONS BURNED
 23   3 90 006 01 INDUSTRIAL PROCES/INPROCESS FUEL   /NATURAL GAS       / ASPHALT DRYER      /MILLION CUBIC FEET BURNED
724   3 90 006 02 INDUSTRIAL PROCES/INPROCESS FUEL   /NATURAL GAS       / CEMENT KILN        /MILLION CUBIC FEET BURNED
725   3 90 006 03 INDUSTRIAL PROCES/INPROCESS FUEL   /NATURAL GAS       / LIME KILN          /MILLION CUBIC FEET BURNED
726   3 90 006 04 INDUSTRIAL PROCES/INPROCESS FUEL   /NATURAL GAS       / KAOLIN KILN        /MILLION CUBIC FEET BURNED
727   3 90 006 05 INDUSTRIAL PROCES/INPROCESS FUEL   /NATURAL GAS       / METAL MELTING      /MILLION CUBIC FEET BURNED
728   3 90 006 06 INDUSTRIAL PROCES/INPROCESS FUEL   /NATURAL GAS       / BRICK KILN/DRYS    /MILLION CUBIC FEET BURNED
729   3 90 006 07 INDUSTRIAL PROCES/INPROCESS FUEL   /NATURAL GAS       / GYPSUM KILN ETC    /MILLION CUBIC FEET BURNED
730   3 90 006 99 INDUSTRIAL PROCES/INPROCESS FUEL   /NATURAL GAS       / OTHER/NOT CLASIFD  /MILLION CUBIC FEET BURNED
731   3 90 007 99 INDUSTRIAL PROCES/INPROCESS FUEL   /PROCESS GAS       / OTHER/NOT CLASIFD  /MILLION CUBIC FEET BURNED
732   3 90 008 99 INDUSTRIAL PROCES/INPROCESS FUEL   /COKE              / OTHER/NOT CLASIFD  /TONS
733   3 90 009 99 INDUSTRIAL PROCES/INPROCESS FUEL   /WOOD              / OTHER/NOT CLASIFD  /TONS BURNED
734   3 90 999 97 INDUSTRIAL PROCES/INPROCESS FUEL   /OTHER/NOT CLASIFD/ SPECIFY IN REMARK   /MILLION CUBIC FEET BURNED
735   3 90 999 98 INDUSTRIAL PROCES/INPROCESS FUEL   /OTHER/NOT CLASIFD/ SPECIFY IN REMARK   /1000 GALLONS BURNED
736   3 90 999 99 INDUSTRIAL PROCES/INPROCESS FUEL   /OTHER/NOT CLASIFD/ SPECIFY IN REMARK   /TONS BURNED
737   3 99 999 99 INDUSTRIAL PROCES/OTHER/NOT CLASIFD/SPECIFY IN REMARK/                     /TONS PROCESSED
738   4 01 001 01 POINT SC EVAP     /CLEANING SOLVENT /DRYCLEANING       / PERCHLORETHYLENE   /TONS CLOTHES CLEANED
739   4 01 001 02 POINT SC EVAP     /CLEANING SOLVENT /DRYCLEANING       / STODDARD           /TONS CLOTHES CLEANED
740   4 01 002 01 POINT SC EVAP     /CLEANING SOLVENT /DEGREASING        / STODDARD           /TONS SOLVENT USED
741   4 01 002 99 POINT SC EVAP     /CLEANING SOLVENT /DEGREASING        / OTHER/NOT CLASIFD  /TONS SOLVENT USED
742   4 01 999 99 POINT SC EVAP     /CLEANING SOLVENT /OTHER/NOT CLASIFD/ SPECIFY IN REMARK   /TONS SOLVENT USED
743   4 02 003 01 POINT SC EVAP     /SURFACE COATING  /VARNISH/SHELLAC  / GENERAL             /TONS COATING
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744   4 02 001 01 POINT SC EVAP   /SURFACE COATING  /PAINT             / GENERAL            /TONS COATING
745   4 02 004 01 POINT SC EVAP   /SURFACE COATING  /LAQUER            / GENERAL            /TONS COATING
746   4 02 005 01 POINT SC EVAP   /SURFACE COATING  /ENAMEL            / GENERAL            /TONS COATING
747   4 02 006 01 POINT SC EVAP   /SURFACE COATING  /PRIMER            / GENERAL            /TONS COATING
748   4 02 999 99 POINT SC EVAP   /SURFACE COATING  /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS COATING
749   4 03 001 01 POINT SC EVAP   /PETROLEUM STG    /FIXED ROOF        / BREATHING-PRODUCT /1000 GALLONS STORAGE CAPACITY
750   4 03 001 02 POINT SC EVAP   /PETROLEUM STG    /FIXED ROOF        / BREATHING CRUDE   /1000 GALLONS STORAGE CAPACITY
751   4 03 001 03 POINT SC EVAP   /PETROLEUM STG    /FIXED ROOF        / WORKING-PRODUCT   /1000 GALLONS THROUGHPUT
752   4 03 001 04 POINT SC EVAP   /PETROLEUM STG    /FIXED ROOF        / WORKING CRUDE     /1000 GALLONS THROUGHPUT
753   4 03 002 01 POINT SC EVAP   /PETROLEUM STG    /FLOATING ROOF     / BREATHING PRODUCT /1000 GALLONS STORAGE CAPACITY
754   4 03 002 02 POINT SC EVAP   /PETROLEUM STG    /FLOATING ROOF     / WORKING-PRODUCT   /1000 GALLONS THROUGHPUT
755   4 03 002 03 POINT SC EVAP   /PETROLEUM STG    /FLOATING ROOF     / BREATHING-CRUDE   /1000 GALLONS STORAGE CAPACITY
756   4 03 002 04 POINT SC EVAP   /PETROLEUM STG    /FLOATING ROOF     / WORKING-CRUDE     /1000 GALLONS THROUGHPUT
757   4 03 999 99 POINT SC EVAP   /PETROLEUM STG    /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /1000 GAL STORED
758   4 04 001 99 POINT SC EVAP   /MISC ORGANIC STOR/OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS STORED
759   4 05 001 01 POINT SC EVAP   /PRINTING PRESS   /DRYERS            / GENERAL            /TONS SOLVENT
760   4 90 999 99 POINT SC EVAP   /MISC HC EVAP     /OTHER/NOT CLASIFD/ SPECIFY IN REMARK /TONS PROCESSED
761   5 01 001 01 SOLID WASTE     /GOVERNMENT       /MUNICIPAL INCIN  / MULTIPLE CHAMBER  /TONS BURNED
762   5 01 001 02 SOLID WASTE     /GOVERNMENT       /MUNICIPAL INCIN  / SINGLE CHAMBER    /TONS BURNED
763   5 01 002 01 SOLID WASTE     /GOVERNMENT       /OPEN BURNING DUMP/ GENERAL           /TONS BURNED
764   5 01 002 02 SOLID WASTE     /GOVERNMENT       /OPEN BURNING DUMP/ LANDSCAPE/PRUNING /TONS BURNED
765   5 01 002 03 SOLID WASTE     /GOVERNMENT       /OPEN BURNING DUMP/ JET FUEL          /HUNDREDS OF GALLONS
766   5 01 005 05 SOLID WASTE     /GOVERNMENT       /INCINERATOR      / PATHOLOGICAL      /TONS BURNED
767   5 01 005 06 SOLID WASTE     /GOVERNMENT       /INCINERATOR      / SLUDGE            /TONS DRY SLUDGE
768   5 01 005 07 SOLID WASTE     /GOVERNMENT       /INCINERATOR      / CONICAL           /TONS BURNED
769   5 01 005 99 SOLID WASTE     /GOVERNMENT       /INCINERATOR      / OTHER/NOT CLASIFD /TONS BURNED
770   5 01 900 04 SOLID WASTE     /GOVERNMENT       /AUX.FULL/NO EMSNS/ RESIDUAL OIL      /1000 GALLONS
771   5 01 900 05 SOLID WASTE     /GOVERNMENT       /AUX.FUEL/NO EMSNS/ DISTILLATE OIL    /1000 GALLONS
772   5 01 900 06 SOLID WASTE     /GOVERNMENT       /AUX.FUEL/NO EMSNS/ NATURAL GAS       /MILLION CUBIC FEET
773   5 01 900 10 SOLID WASTE     /GOVERNMENT       /AUX.FUEL/NO EMSNS/ LPG               /1000 GALLONS
774   5 01 900 97 SOLID WASTE     /GOVERNMENT       /AUX.FUEL/NO EMSNS/ OTHER/NOT CLASIFD /MILLION CUBIC FEET
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775   5 01 900 98 SOLID WASTE    /GOVERNMENT     /AUX.FUEL/NO EMSNS/ OTHER/NOT CLASIFD /1000 GALLONS
776   5 01 900 99 SOLID WASTE    /GOVERNMENT     /AUX.FUEL/NO EMSNS/ OTHER/NOT CLASIFD /TONS
777   5 02 001 01 SOLID WASTE    /COMM-INST      /INCINERATOR GEN  / MULTIPLE CHAMBER  /TONS BURNED
778   5 02 001 02 SOLID WASTE    /COMM-INST      /INCINERATOR GEN  / SINGLE CHAMBER    /TONS BURNED
779   5 02 001 03 SOLID WASTE    /COMM-INST      /INCINERATOR GEN  / CONTROLLED AIR    /TONS BURNED
780   5 02 001 04 SOLID WASTE    /COMM-INST      /INCINERATOR GEN  / CONICAL REFUSE    /TONS BURNED
781   5 02 001 05 SOLID WASTE    /COMM-INST      /INCINERATOR GEN  / CONICAL WOOD      /TONS BURNED
782   5 02 002 01 SOLID WASTE    /COMM-INST      /OPEN BURNING     / WOOD              /TONS BURNED
783   5 02 003 01 SOLID WASTE    /COMM-INST      /APARTMENT INCIN  / FLUE FED          /TONS BURNED
784   5 02 003 02 SOLID WASTE    /COMM-INST      /APARTMENT INCIN  / FLUE FED-MODIFIED /TONS BURNED
785   5 02 005 05 SOLID WASTE    /COMM-INST      /INCINERATOR      / PATHOLOGICAL      /TONS BURNED
786   5 02 005 06 SOLID WASTE    /COMM-INST      /INCINERATOR      / SLUDGE            /TONS DRY SLUDGE
787   5 02 005 99 SOLID WASTE    /COMM-INST      /INCINERATOR      / OTHER/NOT CLASIFD /TONS BURNED
788   5 02 900 04 SOLID WASTE    /COMM-INST      /AUX.FUEL/NO EMSNS/ RESIDUAL OIL      /1000 GALLONS
789   5 02 900 05 SOLID WASTE    /COMM-INST      /AUX.FUEL/NO EMSNS/ DISTILLATE OIL    /1000 GALLONS
790   5 02 900 06 SOLID WASTE    /COMM-INST      /AUX.FUEL/NO EMSNS/ NATURAL GAS       /MILLION CUBIC FEET
791   5 02 900 10 SOLID WASTE    /COMM-INST      /AUX.FUEL/NO EMSNS/ LPG               /1000 GALLONS
792   5 02 900 97 SOLID WASTE    /COMM-INST      /AUX.FUEL/NO EMSNS/ OTHER/NOT CLASIFD /MILLION CUBIC FEET
793   5 02 900 98 SOLID WASTE    /COMM-INST      /AUX.FUEL/NO EMSNS/ OTHER/NOT CLASIFD /1000 GALLONS
794   5 02 900 99 SOLID WASTE    /COMM-INST      /AUX.FUEL/NO EMSNS/ OTHER/NOT CLASIFD /TONS
795   5 03 001 01 SOLID WASTE    /INDUSTRIAL     /INCINERATOR      / MULTIPLE CHAMBER  /TONS BURNED
796   5 03 001 02 SOLID WASTE    /INDUSTRIAL     /INCINERATOR      / SINGLE CHAMBER    /TONS BURNED
797   5 03 001 03 SOLID WASTE    /INDUSTRIAL     /INCINERATOR      / CONTROLLED AIR    /TONS BURNED
798   5 03 001 04 SOLID WASTE    /INDUSTRIAL     /INCINERATOR      / CONICAL REFUSE    /TONS BURNED
799   5 03 001 05 SOLID WASTE    /INDUSTRIAL     /INCINERATOR      / CONICAL WOOD      /TONS BURNED
800   5 03 001 06 SOLID WASTE    /INDUSTRIAL     /INCINERATOR      / OPEN PIT          /TONS OF WASTE
801   5 03 002 01 SOLID WASTE    /INDUSTRIAL     /OPEN BURNING     / WOOD              /TONS BURNED
802   5 03 002 02 SOLID WASTE    /INDUSTRIAL     /OPEN BURNING     / REFUSE            /TONS BURNED
803   5 03 002 03 SOLID WASTE    /INDUSTRIAL     /OPEN BURNING     / AUTO BODY COMPTS  /TONS BURNED
804   5 03 003 01 SOLID WASTE    /INDUSTRIAL     /AUTO BODY INCINAT/ W/O AFTERBURNER   /AUTOS BURNED
805   5 03 003 02 SOLID WASTE    /INDUSTRIAL     /AUTO BODY INCINAT/ W/ AFTERBURNER    /AUTOS BURNED
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806   5 03 004 01 SOLID WASTE    /INDUSTRIAL     /RAIL CAR BURNING / OPEN           /CARS BURNED
807   5 03 005 06 SOLID WASTE    /INDUSTRIAL     /INCINERATOR      / SLUDGE         /TONS DRY SLUDGE
808   5 03 005 99 SOLID WASTE    /INDUSTRIAL     /INCINERATOR      / OTHER/NOT CLASIFD /TONS BURNED
809   5 03 900 04 SOLID WASTE    /INDUSTRIAL     /AUX.FUEL/NO EMSNS/ RESIDUAL OIL    /1000 GALLONS
810   5 03 900 05 SOLID WASTE    /INDUSTRIAL     /AUX.FUEL/NO EMSNS/ DISTILLATE OIL  /1000 GALLONS
811   5 03 900 06 SOLID WASTE    /INDUSTRIAL     /AUX.FUEL/NO EMSNS/ NATURAL GAS     /MILLION CUBIC FEET
812   5 03 900 07 SOLID WASTE    /INDUSTRIAL     /AUX.FUEL/NO EMSNS/ PROCESS GAS     /MILLION CUBIC FEET
813   5 03 900 10 SOLID WASTE    /INDUSTRIAL     /AUX.FUEL/NO EMSNS/ L P G           /1000 GALLONS
814   5 03 900 97 SOLID WASTE    /INDUSTRIAL     /AUX.FUEL/NO EMSNS/ OTHER/NOT CLASIFD /MILLION CUBIC FEET
815   5 03 900 98 SOLID WASTE    /INDUSTRIAL     /AUX.FUEL/NO EMSNS/ OTHER/NOT CLASIFD /1000 GALLONS
816   5 03 900 99 SOLID WASTE    /INDUSTRIAL     /AUX.FUEL/NO EMSNS/ OTHER/NOT CLASIFD /TONS
821          EXT COMBUSTION RESIDENTIAL ANTHRACITE COAL
822          EXT COMBUSTION RESIDENTIAL BITUMINOUS COAL
823          EXT COMBUSTION RESIDENTIAL DISTILLATE OIL
824          EXT COMBUSTION RESIDENTIAL RESIDUAL OIL
825          EXT COMBUSTION RESIDENTIAL NATURAL GAS
826          EXT COMBUSTION RESIDENTIAL WOOD
827          EXT COMBUSTION INDUSTRIAL  ANTHRACITE COAL
828          EXT COMBUSTION INDUSTRIAL  BITUMINOUS COAL
829          EXT COMBUSTION INDUSTRIAL  RESIDUAL OIL
830          EXT COMBUSTION INDUSTRIAL  DISTILLATE OIL
831          EXT COMBUSTION INDUSTRIAL  NATURAL GAS
832          EXT COMBUSTION INDUSTRIAL  PROCESS GAS
833          EXT COMBUSTION INDUSTRIAL  WOOD
834          EXT COMBUSTION COMM/INST   ANTHRACITE COAL
835          EXT COMBUSTION COMM/INST   BITUMINOUS COAL
836          EXT COMBUSTION COMM/INST   RESIDUAL OIL
837          EXT COMBUSTION COMM/INST   DISTILLATE OIL
838          EXT COMBUSTION COMM/INST   NATURAL GAS
839          EXT COMBUSTION COMM/INST   WOOD
840          SOLID WASTE 01 RESIDENTIAL ON SITE INCINER
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841	SOLID WASTE DI	RESIDENTIAL	OPEN BURNING
842	SOLID WASTE DI	COMM/INST	ON SITE INCINER
843	SOLID WASTE DI	COMM/INST	OPEN BURNING
844	SOLID WASTE DI	INDUSTRIAL	ON SITE INCINER
845	SOLID WASTE	INDUSTRIAL	OPEN BURNING
846	TRANSPORTATION	GASOLINE	LIGHT VEHICLES
847	TRANSPORTATION	GASOLINE	HEAVY VEHICLES
848	TRANSPORTATION	GASOLINE	OFF HIGHWAY
849	TRANSPORTATION	DIESEL	HEAVY VEHICLES
850	TRANSPORTATION	DIESEL	OFF HIGHWAY
851	TRANSPORTATION	DIESEL	RAIL
852	TRANSPORTATION	AIR	MILITARY
853	TRANSPORTATION	AIR	CIVIL
854	TRANSPORTATION	AIR	COMMERCIAL
855	TRANSPORTATION	VESSELS	BITUMINOUS COAL
856	TRANSPORTATION	VESSELS	DIESEL FUEL
857	TRANSPORTATION	VESSELS	RESIDUAL OIL
858	TRANSPORTATION	VESSELS	GASOLINE
859	TRANSPORTATION	GASOLINE	HANDLING EVAP LOSS
860	MISCELLANEOUS	GAS HANDLING	EVAP LOSS
861	MISCELLANEOUS	SOLVENT	EVAP LOSS

APPENDIX D

EMISSIONS DATA FOR SOURCES OF AIR POLLUTION IN THE CHICAGO AQCR

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                        EMISSION SOURCES IN COOK      COUNTY

   COUNTY #  SOURCE #        PM       SOX       NOX        CO        HC  HEIGHT, FT.
         1          2       96.     3330.     1050.       35.       11.         292.
         1          8       96.     3330.     1050.       35.       11.         292.
         1          9     1410.    27500.     5420.      301.       90.         378.
         1          9      604.    15300.     3020.      168.       50.         375.
         1          9      805.    21200.     4620.      224.       67.         450.
         1         10      201.     9640.     4810.       88.       26.         213.
         1         10       35.     8380.     4180.       76.       23.         213.
         1         10       36.     8570.     4280.       78.       23.         213.
         1         10       36.     8570.     4280.       78.       23.         213.
         1         10       15.     3330.     1930.       35.       11.         292.
         1         10       15.     3330.     1930.       35.       11.         292.
         1         10      161.     7710.     3850.       70.       21.         213.
         1         11       58.      230.       78.       10.        3.         252.
         1         11      134.       69.       23.        3.        2.         252.
         1         11       16.        8.        3.        1.        1.         252.
         1         11       14.        7.        2.        1.        1.         252.
         1         11        2.        1.        1.        1.        1.         252.
         1         36       10.      248.     2080.       59.       43.         213.
         1         36       10.      253.     2110.       60.       40.         213.
         1         36        1.       32.      270.        8.        5.         213.
         1         36        1.       21.      175.        5.        3.         213.
         1         36        1.       21.      175.        5.        3.         213.
         1         42        1.        1.       95.        3.        1.         213.
         1         42        1.        1.       14.        1.        1.         213.
         1         42        1.        1.      103.        3.        1.         213.
         1         42        1.        1.      112.        3.        1.         213.
         1         42        1.        1.      112.        3.        1.         213.
         1         42        2.        4.     3660.      104.        6.         378.
         1         42        1.        2.     2220.       63.        4.         375.
         1         42        4.        1.      143.        4.        1.         185.
         1         42        4.        1.      143.        4.        1.         185.
         1         42        4.        1.      143.        4.        1.         185.
         1         42        4.        1.      143.        4.        1.         185.
         1         42        4.        1.      143.        4.        1.         185.
         1         42        4.        1.      143.        4.        1.         185.
         1         42        1.        1.      164.        5.        1.         252.
         1         42        1.        1.       41.        1.        1.         252.
         1         42        2.        4.     3970.      112.        7.         450.
         1         65      928.     2280.     1800.       60.       18.         226.
         1         65      928.     2280.     1800.       60.       18.         226.
         1         65      928.     2280.     1800.       60.       18.         226.
         1         66       87.      182.      108.        6.        2.          80.
         1         66       87.      182.      108.        6.        2.          80.
         1         66       87.      182.      108.        6.        2.          80.
         1         68      201.     4020.      456.       61.       30.         150.
         1         70       90.      103.       45.        6.        3.          90.
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1    70   120.   137.    95.    8.    4.         98.
1    70    90.   103.    45.    6.    3.         90.
1    70    90.   103.    45.    6.    3.         90.
1    70   240.   410.   137.   10.    9.         85.
1    70   370.   624.   205.   27.   14.        150.
1    73   106.    47.    17.    2.    1.          0.
1    73    19.   247.    45.    7.    3.          0.
1    73    19.   247.    49.    7.    3.          0.
1    79   143.   610.   344.   46.    7.         60.
1    79   143.   610.   344.   46.    7.         60.
1    79   143.   610.   344.   46.    7.         60.
1    96     1.     4.     3.    1.    1.         24.
1    96    72.   416.   187.   12.    9.        120.
1    96    21.   283.    54.    4.    3.          0.
1    96    10.   107.    27.    2.    1.         55.
1    96    29.   710.   181.   12.    9.        245.
1    96    52.    92.   135.    9.    7.         90.
1    96    36.   366.    93.    6.    5.        150.
1    96     1.     4.     3.    1.    1.        175.
1    96    15.   104.    40.    3.    2.        150.
1    97    12.   118.    30.    2.    2.         50.
1    97     1.     5.     1.    1.    1.         60.
1    97     1.    73.    19.    1.    1.         60.
1    97     1.    43.    11.    1.    1.         45.
1    97     1.    24.     6.    1.    1.         45.
1    97     1.   119.    30.    2.    2.        115.
1    97    12.   120.    31.    2.    2.         53.
1    97     3.    65.    12.    1.    1.         66.
1    97     2.    19.     5.    1.    1.          0.
1    97     5.    63.    12.    1.    1.         22.
1    97    14.   167.    38.    3.    2.         28.
1    97     1.    12.     3.    1.    1.         40.
1    97     1.     3.     3.    1.    1.         40.
1    97     1.     5.     4.    1.    1.         70.
1    97    14.   144.    37.    2.    2.        105.
1    97    12.   118.    30.    2.    2.         43.
1    97     9.    83.    24.    2.    1.         30.
1    97    12.    39.    30.    2.    2.         35.
1    97     2.     6.     4.    1.    1.         30.
1    97     1.     7.     1.    1.    1.         60.
1    97    10.   166.    25.    2.    1.         30.
1    97     3.    50.     8.    1.    1.         75.
1    97    21.   141.    54.    4.    3.         90.
1    97     2.    25.     5.    1.    1.         30.
1    97     7.   118.    18.    1.    1.         30.
1    97     7.   118.    18.    1.    1.         30.
1    97     7.   118.    18.    1.    1.         30.
1    97     7.   118.    18.    1.    1.         30.
1    97    28.   377.    72.    5.    4.         75.
1    98    39.   396.   101.    7.    5.        178.
1    98     1.    12.     2.    1.    1.         35.
1    98     3.    60.    14.    1.    1.         49.
1    98     1.     8.     2.    1.    1.         28.
1    98    15.   141.    38.    3.    2.         30.
1    98    31.   105.    80.    6.    4.         46.
1    98     1.     6.     1.    1.    1.         20.
1    98     8.    85.    22.    1.    1.         20.
1    98     9.    58.    22.    1.    1.         60.
1    98     4.    34.    10.    1.    1.         40.
1    98     1.     6.     1.    1.    1.         20.
1    99     1.    12.     3.    1.    1.         34.
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1    99     1.    13.     3.     1.     1.      34.
1   101     1.     2.     2.     1.     1.      38.
1   101     1.     6.     5.     1.     1.      80.
1   101     1.     6.     5.     1.     1.      25.
1   102     1.     1.     3.     1.     1.      24.
1   102    10.     1.   124.     9.     2.     205.
1   102    11.     1.   138.    10.     2.     245.
1   102     2.     1.    25.     2.     1.      90.
1   102     5.     1.    61.     4.     1.     150.
1   102     4.     1.    49.     4.     1.     150.
1   102     1.     1.     5.     1.     1.       0.
1   103     1.     1.     4.     1.     1.      50.
1   103     1.     1.    28.     2.     1.      57.
1   103     2.     1.    24.     2.     1.      55.
1   103     1.     1.     9.     1.     1.      60.
1   103     1.     1.     5.     1.     1.      45.
1   103     1.     1.     3.     1.     1.      45.
1   103     1.     1.    14.     1.     1.     115.
1   103     1.     1.     3.     1.     1.      49.
1   103     1.     1.    12.     1.     1.      55.
1   103     1.     1.    11.     1.     1.      22.
1   103     1.     1.    31.     2.     1.       0.
1   103     6.     1.    73.     5.     1.      60.
1   103     1.     1.     5.     1.     1.      80.
1   103     1.     1.     9.     1.     1.      32.
1   103     1.     1.     2.     1.     1.      30.
1   103     3.     1.    39.     3.     1.      80.
1   103     1.     1.     3.     1.     1.      80.
1   103     8.     1.    97.     7.     1.      90.
1   103     8.     1.    97.     7.     1.      90.
1   103     8.     1.    97.     7.     1.     100.
1   103     8.     1.    97.     7.     1.     100.
1   103     8.     1.    97.     7.     1.     120.
1   103     8.     1.    97.     7.     1.     120.
1   103     1.     1.     9.     1.     1.      90.
1   103     1.     1.     6.     1.     1.      30.
1   103     1.     1.     6.     1.     1.      30.
1   103     1.     1.     6.     1.     1.      30.
1   103     1.     1.     6.     1.     1.      30.
1   103     1.     1.     6.     1.     1.      30.
1   103     1.     1.     6.     1.     1.      30.
1   103     1.     1.     4.     1.     1.      75.
1   104    27.     1.   180.    26.     5.     178.
1   104     1.     1.     3.     1.     1.      49.
1   104     1.     1.     2.     1.     1.      35.
1   104    27.     1.   180.    26.     5.      54.
1   104    27.     1.   180.    26.     5.      53.
1   104    27.     1.   180.    26.     5.      23.
1   104     1.     1.     2.     1.     1.     100.
1   104     1.     1.     2.     1.     1.      38.
1   104     1.     1.     8.     1.     1.      20.
1   104     1.     1.     2.     1.     1.      73.
1   104     1.     1.     2.     1.     1.      55.
1   104     1.     1.     8.     1.     1.      23.
1   104     1.     1.     2.     1.     1.      40.
1   104    11.     1.    75.    11.     2.      34.
1   104    11.     1.    75.    11.     2.      34.
1   104     1.     1.     2.     1.     1.      60.
1   104     1.     1.     3.     1.     1.      25.
1   105    82.  4020.   952.    71.    12.     120.
1   130    34.    74.    10.     1.     1.       0.
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I     130      8.    105.     45.      6.      3.       0.
I     130    209.    117.     38.      5.      3.       0.
I     135      1.     17.      1.     14.      3.       0.
I     147      0.     39. [illegible]  1.      1.       0.
I     147     31.    212.     81.      5.      4.       0.
I     148      2.     11.      4.      1.      1.       0.
I     148      3.     19.      7.      1.      1.       0.
I     148      2.      9.      8.      1.      1.       0.
I     148      2.      9.      5.      1.      1.       0.
I     149      1.      2.      2.      1.      1.       0.
I     149      1.      9.      3.      1.      1.       0.
I     149      1.      3.      1.      1.      1.       0.
I     149      1.      3.      1.      1.      1.       0.
I     149      1.      3.      1.      1.      1.       0.
I     149      1.      2.      1.      1.      1.       0.
I     149      1.      4.      1.      1.      1.     120.
I     149      1.      4.      1.      1.      1.     120.
I     151      1.      6.      8.      1.      1.       0.
I     151      1.      3.      3.      1.      1.       0.
I     151     16.     79.     36.      4.      3.       0.
I     151      5.     20.     18.      1.      1.       0.
I     151      3.     15.     11.      1.      1.       0.
I     152      1.      3.      2.      1.      1.       0.
I     152      1.      2.      2.      1.      1.       0.
I     152      1.      2.      2.      1.      1.       0.
I     154      1.      1.      8.      1.      1.       0.
I     154      1.      1.      6.      1.      1.       0.
I     154      0.      1.     54.      9.      4.       0.
I     154      1.      1.      3.      1.      1.       0.
I     179      0.      0.    200.      0.      0.      30.
I     181      0.      0.      0.      0.    749.      24.
I     183      0.      0.      0.    203.      0.      40.
I     183      0.      0.      0.    105.      0.      30.
I     183      0.      0.      0.   1250.      0.      24.
I     205    110.      0.      0.      0.      0.      25.
I     205   1100.      0.      0.      0.      0.      30.
I     205    148.      0.      0.      0.      0.       0.
I     205     59.      0.      0.      0.      0.      30.
I     205    112.      0.      0.      0.      0.      50.
I     230      0.      0.      0.      0.    150.      14.
I     230     17.      0.      0.      0.    130.      25.
I     234      0.      0.      0.      0.    131.      28.
I     244    414.      0.      0.      0.      0.      25.
I     247    219.      0.      0.      0.      0.      45.
I     249      0.      0.      0.      0.    263.      22.
I     301    173.      0.      0.      0.      0.      50.
I     305    599.      0.      0.      0.      0.      70.
I     306    403.      0.      0.      0.      0.      28.
I     333     34.      0.      0.      0.      0.      45.
I     333      0.      0.      0.      0.      0.      75.
I     333    141.      0.      0.      0.   1260.      32.
I     345      5.      0.      0.      0.      0.      33.
I     346     11.      0.      0.      0.      0.      33.
I     346     44.      0.      0.      0.      0.      25.
I     347     26.      0.      0.      0.      0.      33.
I     349   3710.      0.      0.      0.      0.      26.
I     350   1120.      0.      0.      0.      0.      25.
I     351    657.      0.      0.      0.      0.      25.
I     352    408.      0.      0.      0.      0.      50.
I     379     42.      0.      0.      0.      0.      33.
I     389    215.      0.      0.      0.      0.      33.
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I      400   1310.      1.      2.      49.   190.        100.
I      401    220.      1.      2.      49.   190.        100.
I      402    780.      1.      2.      49.   190.        100.
I      425    242.      0.      0.     787.     0.        100.
I      427    149.      0.      0.    5200.     0.         75.
I      427   4360.      0.      0.       0.     0.        100.
I      429     88.      0.      2.     131.   378.        100.
I      433     38.      0.      0.       0.     0.        100.
I      435    592.      0.      0.    1610.     0.         50.
I      436      5.      0.      0.     828.     0.         51.
I      436      5.      0.      0.     828.     0.         51.
I      436      5.      0.      0.     828.     0.         51.
I      436     96.      0.      0.    7880.     0.        100.
I      437    111.      0.      0.       0.     0.        150.
I      437      2.      0.      0.       0.     0.         36.
I      438    131.      0.      0.       0.     0.         20.
I      438      0.     26.      0.       0.     0.         75.
I      463    518.      0.      0.       0.     0.         86.
I      471    158.      0.      0.       0.     0.         40.
I      471     53.      0.      0.       0.     0.         30.
I      471     90.      0.      0.       0.     0.         35.
I      472     61.      0.      0.       0.     0.        100.
I      474    613.      0.      0.       0.     0.         60.
I      474    101.      0.      0.       0.     0.         25.
I      475    197.      0.      0.       0.     0.         50.
I      475     36.      0.      0.       0.     0.         25.
I      476     90.      0.      0.       0.     0.         35.
I      477    372.      0.      0.    2100.     0.         60.
I      477    504.      0.      0.   23900.     0.          0.
I      477      6.      0.      0.      51.     0.         40.
I      477     30.      0.      0.     254.     0.         45.
I      478      4.      0.      0.       0.     0.         50.
I      478      3.      0.      0.       0.     0.         60.
I      479     12.      0.      0.       0.     0.         40.
I      485    569.   3720.      0.       0.     0.         32.
I      494     42.      0.      4.       0.     0.         50.
I      494      2.      0.      2.       0.     0.         40.
I      495    542.      0.     16.       0.     0.         36.
I      495      2.      0.      0.       0.     0.         20.
I      499      2.      0.      0.       0.   160.         25.
I      500     41.      0.      0.       0.     0.         40.
I      502      3.      0.      0.       0.     0.         32.
I      504     11.      0.      0.       0.     0.         25.
I      520    210.      0.      0.       0.     0.         30.
I      522      8.      0.      0.     138.     0.         20.
I      524      9.      0.      0.       0.     0.         10.
I      525      9.      0.      0.      20.     0.        100.
I      527      6.      0.      0.       0.     0.         30.
I      527      4.      0.      0.       0.     0.         36.
I      527    307.      5.      3.       0.     0.         35.
I      527     10.      0.      0.       0.     0.         68.
I      527     15.      0.      0.       0.     0.         40.
I      527    307.      0.      0.       0.     0.         45.
I      528   1630.      0.      0.       0.     0.         30.
I      528     88.      0.      0.       0.     0.         40.
I      528      3.      0.      0.       0.     0.         60.
I      528   4200.      0.      0.       0.     0.         30.
I      528   1910.      0.      0.       0.     0.         40.
I      528     44.      0.      0.       0.     0.         45.
I      530    550.      0.      0.       0.     0.         20.
I      531   1550.      0.      0.       0.     0.         60.
```

1	547	1360.	0.	0.	0.	0.	30.
1	548	539.	0.	0.	0.	0.	30.
1	582	153.	0.	0.	0.	0.	80.
1	592	462.	0.	0.	0.	0.	65.
1	595	834.	0.	0.	0.	0.	65.
1	595	2270.	0.	0.	0.	0.	75.
1	595	7550.	0.	0.	0.	0.	75.
1	595	7550.	0.	0.	0.	0.	75.
1	595	7550.	0.	0.	0.	0.	75.
1	595	156.	0.	0.	0.	0.	45.
1	612	315.	0.	0.	0.	0.	40.
1	615	353.	0.	0.	0.	0.	40.
1	615	164.	0.	0.	0.	0.	20.
1	617	18.	0.	0.	0.	0.	75.
1	617	2.	0.	0.	0.	0.	75.
1	617	45300.	0.	0.	0.	0.	75.
1	617	975.	0.	0.	0.	0.	75.
1	632	3290.	0.	0.	0.	0.	20.
1	634	0.	0.	952.	0.	124.	80.
1	637	70.	2050.	293.	37000.	915.	0.
1	637	79.	162.	23.	4490.	72.	20.
1	651	0.	12.	0.	0.	0.	208.
1	658	0.	2870.	0.	0.	0.	250.
1	658	0.	2870.	0.	0.	0.	250.
1	658	2630.	8850.	0.	0.	0.	200.
1	658	0.	0.	0.	0.	343.	0.
1	677	8.	0.	0.	0.	0.	28.
1	692	288.	0.	0.	0.	0.	25.
1	693	197.	0.	0.	0.	0.	40.
1	714	0.	5.	3.	0.	0.	35.
1	730	0.	5.	3.	0.	0.	35.
1	731	242.	0.	0.	0.	0.	100.
1	737	0.	0.	0.	0.	63.	20.
1	737	0.	0.	0.	0.	3400.	0.
1	743	0.	0.	0.	0.	147.	40.
1	743	0.	0.	0.	0.	1470.	30.
1	743	0.	0.	0.	0.	736.	20.
1	743	0.	0.	0.	0.	1230.	150.
1	743	0.	0.	0.	0.	147.	25.
1	743	0.	0.	0.	0.	147.	20.
1	743	0.	0.	0.	0.	147.	30.
1	743	0.	0.	0.	0.	245.	22.
1	743	0.	0.	0.	0.	1810.	25.
1	743	0.	0.	0.	0.	203.	40.
1	743	101.	0.	0.	0.	0.	20.
1	743	0.	0.	0.	0.	98.	45.
1	743	0.	0.	0.	0.	147.	20.
1	743	0.	0.	0.	0.	191.	20.
1	743	0.	0.	0.	0.	196.	33.
1	743	0.	0.	0.	0.	1230.	25.
1	743	0.	0.	0.	0.	196.	10.
1	743	0.	0.	0.	0.	147.	60.
1	743	0.	0.	0.	0.	245.	30.
1	743	0.	0.	0.	0.	133.	25.
1	743	0.	0.	0.	0.	49.	20.
1	743	0.	0.	0.	0.	[illegible]	117.
1	743	0.	0.	0.	0.	589.	50.
1	744	0.	0.	0.	0.	482.	25.
1	744	0.	0.	0.	0.	88.	20.
1	745	0.	0.	0.	0.	27000.	45.
1	745	0.	0.	0.	0.	10100.	20.

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1     745      0.       0.       0.       0.     472.          20.
1     745      0.       0.       0.       0.      13.          45.
1     745      0.       0.       0.       0.     540.          20.
1     746      0.       0.       0.       0.    4230.          28.
1     747      0.       0.       0.       0.    2200.          80.
1     747      0.       0.       0.       0.     607.          20.
1     749      0.       0.       0.       0.    8870.          50.
1     749      0.       0.       0.       0.      85.          48.
1     749      0.       0.       0.       0.      72.          60.
1     749      0.       0.       0.       0.     161.          60.
1     751      0.       0.       0.       0.    3010.          16.
1     751      0.       0.       0.       0.     306.          40.
1     758      0.       0.       0.       0.     276.          15.
1     760      0.       0.       0.       0.     477.          35.
1     761      9.       0.       1.      10.       1.           0.
1     761     91.       0.       8.     108.       3.           0.
1     761    775.      65.      52.     904.      39.           0.
1     761   1240.     230.     184.    3220.     138.         200.
1     761    552.      77.      61.    1070.      46.          40.
1     761    552.      77.      61.    1070.      46.          40.
1     761   2180.     182.     145.    2540.     109.         250.
1     761   2180.     182.     145.    2540.     109.         250.
1     761   2180.     182.     145.    2540.     109.         250.
1     762     10.       2.       1.      13.      10.           0.
1     762      3.       1.       1.       4.       3.           0.
1     762    657.     110.      88.     876.     657.         125.
1    -762    105.      88.      70.     701.     526.          40.
1     776     20.       3.       2.      26.      20.          40.
1     782     26.       0.       3.      77.       6.           5.
1     782    365.       0.      43.    1670.      86.           5.
1     782    655.       0.      77.    1930.     154.           5.
1     783     13.       1.       1.       4.       7.           0.
1     795      7.       7.       8.      26.       8.           0.
1     796     13.       2.       2.      18.      13.           0.
1     796      3.       1.       1.       4.       3.          60.
1     798     13.       2.       2.      17.      13.         115.
1     796   1640.     274.     219.    2190.    1640.         250.
1     796   1640.     274.     219.    1640.    2190.         250.
1     822  10000.   33199.    1300.   45000.   11000.          25.
1     823   4433.   28121.    2220.    2617.    1330.          25.
1     825   2152.      68.    5863.    2265.     906.          25.
1     826     11.       0.       4.       1.       1.          25.
1     828  76840.   78614.   11083.    1478.     739.          25.
1     829    748.    8108.    1951.       7.      48.          25.
1     830    600.    2271.    2395.       8.     120.          25.
1     831   1148.      39.   11481.    2551.      26.          25.
1     836   3424.   23372.    8972.      30.     447.          25.
1     838    849.      20.    3413.     663.     273.          25.
1     840   2867.      46.      96.   28672.    5557.          25.
1     841   1176.      73.     441.    6247.    2499.           3.
1     842    362.      48.      64.     636.     318.          25.
1     843    393.      25.     147.    2607.     835.           3.
1     844  10233.    2029.    2765.   27055.   13527.          25.
1     845  10822.     676.    4058.   57494.   22998.          25.
1     846   7233.    4340. 103667.1060254.  208970.           3.
1     847    347.     208.   11554.   86236.   21745.           3.
1     848      8.       5.     181.    3116.     509.           3.
1     849    825.    1651.   23384.   13755.    2338.           3.
1     850     65.     135.    1648.    1124.     185.           3.
1     851   2033.    8205.    6098.    5691.    4066.          25.
1     852    186.      36.      89.     465.     433.          25.
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OEI
300

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          1        853      67.      13.      61.    1666.     247.              25.
          1        854    3204.     711.    2608.   18266.    7731.              25.
          1        856      11.      29.      34.      31.      22.              25.
          1        857       5.      20.      12.       0.       1.              25.
          1        858      22.      14.     451.    6451.    1342.              25.
          1        859       0.       0.       0.       0.   16379.               3.
          1        861       0.       0.       0.       0.  168604.              25.

                     EMISSION SOURCES IN DUPAGE   COUNTY

   COUNTY #  SOURCE #       PM      SOX      NOX       CO       HC  HEIGHT, FT.

          2         36      17.     165.     221.       6.       4.              40.
          2         36      17.     165.     221.       6.       4.              40.
          2         36      17.     165.     221.       6.       4.              40.
          2         36      17.     165.     221.       6.       4.              40.
          2         36       1.       2.      13.       1.       1.              33.
          2         36       1.       2.      13.       1.       1.              33.
          2         36       1.       2.      13.       1.       1.              33.
          2         36       1.       2.      13.       1.       1.              33.
          2         36       1.       2.      13.       1.       1.              33.
          2         36       1.       2.      13.       1.       1.              33.
          2         42       7.       1.     208.       8.       1.              40.
          2         42       7.       1.     208.       8.       1.              40.
          2         42       7.       1.     208.       8.       1.              40.
          2         42       7.       1.     208.       8.       1.              40.
          2         42       2.       1.      97.       3.       1.              33.
          2         42       2.       1.      97.       3.       1.              33.
          2         42       2.       1.      97.       3.       1.              33.
          2         42       2.       1.      97.       3.       1.              33.
          2         42       2.       1.      97.       3.       1.              33.
          2         42       2.       1.      97.       3.       1.              33.
          2         68    1120.    1220.     218.      29.      15.             120.
          2         73      21.     288.      52.       7.       3.             120.
          2         73      33.     550.      85.      11.       6.             152.
          2         73      41.     686.     106.      14.       7.             152.
          2         73      22.     364.      56.       8.       4.             152.
          2         73      14.     230.      37.       5.       2.             152.
          2         73      29.     478.      74.      10.       5.             152.
          2         97       1.       7.       2.       1.       1.              45.
          2         97       1.       7.       2.       1.       1.              45.
          2        102       1.       1.      69.       5.       1.             152.
          2        103       1.       1.       2.       1.       1.              25.
          2        103       1.       1.      12.       1.       1.             120.
          2        103       1.       1.       2.       1.       1.              45.
          2        103       1.       1.       2.       1.       1.              45.
          2        149       1.       2.       1.       1.       1.               0.
          2        152       1.       2.       1.       1.       1.               0.
          2        743       0.       0.       0.       0.       9.              25.
          2        743       0.       0.       0.       0.     441.              31.
          2        822      16.      84.       2.      71.      15.              25.
          2        823      30.     169.      36.      19.       9.              25.
          2        825     169.       5.     445.     178.      71.              25.
          2        828    2263.    2317.     327.      44.      22.              25.
          2        829      22.     151.      56.       0.       3.              25.
          2        830      18.      67.      71.       0.       4.              25.
          2        831      34.       1.     338.       1.      75.              25.
          2        836     307.    2093.     886.       3.      40.              25.
          2        832      53.       2.     306.      61.      24.              25.
```

2	840	257.	4.	5.	2568.	850.	25.
2	841	706.	7.	40.	501.	224.	3.
2	842	34.	4.	6.	57.	28.	25.
2	843	35.	2.	13.	187.	75.	3.
2	844	1454.	182.	242.	2423.	1211.	25.
2	845	969.	61.	363.	5147.	2059.	25.
2	846	741.	445.	10621.	105862.	21174.	3.
2	847	98.	57.	3188.	23185.	5898.	3.
2	848	20.	16.	564.	4716.	1773.	3.
2	849	135.	276.	3831.	2254.	383.	3.
2	850	12.	25.	348.	211.	35.	3.
2	851	60.	150.	750.	168.	120.	25.
2	852	3.	1.	1.	7.	7.	25.
2	853	33.	7.	30.	831.	145.	25.
2	856	1.	3.	3.	2.	3.	25.
2	859	0.	0.	0.	0.	1714.	3.
2	861	0.	0.	0.	0.	5682.	25.

EMISSION SOURCES IN GRUNDY COUNTY

COUNTY #	SOURCE #	PM	SOX	NOX	CO	HC	HEIGHT, FT.
3	66	2810.	2720.	455.	28.	6.	0.
3	102	7.	1.	95.	7.	1.	50.
3	102	7.	1.	95.	7.	1.	50.
3	559	334.	0.	0.	0.	0.	29.
3	559	524.	0.	1.	0.	0.	29.
3	560	363.	0.	0.	0.	0.	29.
3	560	2660.	0.	1.	0.	0.	29.
3	592	3470.	0.	0.	0.	0.	60.
3	593	353.	0.	0.	0.	0.	60.
3	593	353.	0.	0.	0.	0.	60.
3	748	0.	0.	0.	0.	269.	25.
3	822	31.	273.	8.	231.	31.	25.
3	823	21.	120.	25.	11.	6.	25.
3	825	10.	0.	26.	11.	4.	25.
3	828	185.	139.	27.	4.	2.	25.
3	829	2.	13.	5.	0.	0.	25.
3	830	1.	5.	6.	0.	0.	25.
3	831	3.	0.	28.	0.	6.	25.
3	836	17.	113.	43.	0.	2.	25.
3	839	3.	0.	17.	3.	1.	25.
3	840	63.	1.	2.	831.	277.	25.
3	841	34.	2.	13.	183.	73.	3.
3	842	11.	1.	2.	18.	4.	25.
3	843	11.	1.	4.	59.	24.	3.
3	844	35.	4.	6.	58.	29.	25.
3	845	23.	1.	9.	123.	49.	25.
3	846	101.	61.	1448.	13623.	2818.	3.
3	847	13.	8.	435.	2966.	774.	3.
3	848	8.	5.	181.	31.	504.	3.
3	849	18.	37.	522.	307.	52.	3.
3	850	1.	1.	16.	11.	2.	3.
3	851	5.	13.	15.	14.	10.	25.
3	856	7.	14.	21.	20.	14.	25.
3	857	1.	4.	2.	0.	0.	25.
3	858	0.	0.	10.	165.	30.	25.
3	859	0.	0.	0.	0.	210.	3.
3	861	0.	0.	0.	0.	74.	25.

EMISSION SOURCES IN KANE COUNTY

COUNTY #	SOURCE #	PM	SOX	NOX	CO	HC	HEIGHT, FT.
4	77	10.	38.	6.	10.	3.	60.
4	97	18.	251.	46.	3.	2.	75.
4	97	6.	22.	17.	1.	1.	150.
4	97	6.	22.	17.	1.	1.	150.
4	102	2.	1.	31.	2.	1.	52.
4	102	1.	1.	15.	1.	1.	35.
4	103	1.	1.	6.	1.	1.	75.
4	103	1.	1.	6.	1.	1.	150.
4	103	1.	1.	5.	1.	1.	30.
4	103	1.	1.	4.	1.	1.	45.
4	103	1.	1.	4.	1.	1.	45.
4	103	1.	1.	4.	1.	1.	45.
4	104	1.	1.	2.	1.	1.	70.
4	104	4.	1.	25.	4.	1.	40.
4	104	4.	1.	29.	4.	1.	40.
4	104	9.	1.	58.	8.	1.	40.
4	104	17.	1.	116.	16.	3.	60.
4	104	17.	1.	116.	16.	3.	60.
4	104	17.	1.	116.	16.	3.	60.
4	104	17.	1.	116.	16.	3.	60.
4	104	2.	1.	12.	2.	1.	51.
4	110	2.	1.	1.	1.	1.	80.
4	130	217.	182.	31.	4.	2.	165.
4	130	217.	182.	31.	4.	2.	165.
4	130	217.	132.	31.	4.	2.	165.
4	130	371.	395.	66.	9.	5.	220.
4	130	371.	395.	66.	9.	5.	226.
4	130	569.	473.	75.	10.	5.	163.
4	130	216.	179.	28.	4.	2.	163.
4	145	1.	2.	1.	1.	1.	0.
4	154	1.	1.	5.	2.	1.	225.
4	154	1.	1.	5.	2.	1.	225.
4	463	6.	0.	0.	0.	0.	25.
4	477	1.	0.	0.	483.	0.	35.
4	477	1.	0.	0.	483.	0.	35.
4	479	2.	0.	0.	0.	0.	0.
4	610	150.	0.	0.	0.	0.	5.
4	611	450.	0.	0.	0.	0.	6.
4	615	600.	0.	0.	0.	0.	6.
4	616	374.	0.	0.	0.	0.	20.
4	739	0.	0.	0.	0.	466.	30.
4	743	0.	0.	0.	0.	125.	16.
4	743	0.	0.	0.	0.	461.	20.
4	743	0.	0.	0.	0.	98.	35.
4	743	0.	0.	0.	0.	147.	20.
4	743	0.	0.	0.	0.	49.	60.
4	743	0.	0.	0.	0.	49.	33.
4	743	0.	0.	0.	0.	49.	29.
4	743	0.	0.	0.	0.	56.	29.
4	743	0.	0.	0.	0.	7.	23.
4	743	0.	0.	0.	0.	49.	0.
4	743	0.	0.	0.	0.	245.	3.
4	743	0.	0.	0.	0.	99.	32.
4	745	0.	0.	0.	0.	180.	35.
4	746	0.	0.	0.	0.	66.	30.
4	746	0.	0.	0.	0.	276.	34.

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4	798	10.	16.	13.	131.	99.	225.
4	[illegible]	305.	1630.	46.	1375.	338.	[illegible]
4	823	[illegible]	1699.	232.	97.	98.	25.
4	825	155.	3.	276.	111.	44.	25.
4	828	3643.	3727.	525.	76.	35.	25.
4	829	35.	242.	92.	0.	5.	25.
4	830	28.	104.	114.	0.	6.	25.
4	831	54.	2.	544.	1.	121.	25.
4	836	156.	1000.	408.	20.	1.	25.
4	838	30.	1.	156.	31.	12.	25.
4	840	262.	4.	9.	2620.	873.	25.
4	841	167.	7.	40.	565.	228.	3.
4	842	35.	4.	6.	56.	24.	25.
4	843	36.	2.	13.	191.	76.	3.
4	844	654.	82.	110.	1699.	544.	25.
4	845	439.	27.	165.	2333.	933.	25.
4	846	344.	236.	4932.	49107.	5832.	3.
4	847	44.	27.	1480.	10766.	2739.	3.
4	848	18.	11.	354.	6783.	1236.	3.
4	849	53.	128.	1775.	1046.	175.	3.
4	850	6.	13.	178.	108.	18.	3.
4	851	96.	251.	284.	270.	193.	25.
4	855	0.	0.	0.	0.	6738.	3.
4	861	0.	0.	0.	0.	130.	25.

EMISSION SOURCES IN KANKAKEE COUNTY

COUNTY #	SOURCE #	PM	SOX	NOX	CO	HC	HEIGHT, FT.
5	73	78.	95.	16.	2.	1.	150.
5	73	0.	389.	67.	5.	4.	75.
5	73	24.	389.	67.	9.	4.	75.
5	73	255.	321.	54.	7.	4.	180.
5	73	18.	265.	36.	8.	2.	60.
5	97	29.	491.	75.	5.	4.	20.
5	103	5.	1.	65.	5.	1.	20.
5	103	3.	1.	35.	3.	1.	150.
5	103	3.	1.	42.	3.	1.	75.
5	103	4.	1.	45.	3.	1.	110.
5	103	1.	1.	20.	1.	1.	225.
5	103	1.	1.	20.	1.	1.	225.
5	103	1.	1.	11.	1.	1.	97.
5	104	1.	1.	8.	1.	1.	68.
5	130	510.	496.	75.	10.	5.	165.
5	130	510.	496.	75.	10.	5.	165.
5	130	510.	496.	75.	10.	5.	185.
5	130	510.	516.	75.	10.	5.	185.
5	130	510.	516.	75.	10.	5.	185.
5	130	510.	516.	75.	10.	5.	185.
5	130	332.	351.	53.	7.	4.	215.
5	130	332.	351.	53.	7.	4.	215.
5	130	332.	351.	53.	7.	4.	215.
5	130	332.	351.	53.	7.	4.	215.
5	345	13.	0.	0.	0.	0.	30.
5	477	32.	0.	0.	276.	0.	40.
5	741	0.	0.	0.	0.	679.	20.
5	743	0.	0.	0.	0.	491.	20.
5	795	27.	29.	29.	96.	29.	32.
5	822	267.	1102.	31.	532.	267.	25.

5	823	59.	336.	71.	30.	18.	25.
5	825	27.	1.	76.	28.	11.	25.
5	828	1126.	1154.	163.	22.	11.	25.
5	829	11.	73.	38.	0.	7.	25.
5	830	9.	33.	35.	0.	2.	25.
5	831	17.	1.	168.	0.	37.	25.
5	836	61.	414.	158.	1.	8.	25.
5	838	11.	0.	60.	12.	5.	25.
5	840	259.	4.	9.	2592.	804.	25.
5	841	104.	6.	39.	552.	221.	3.
5	842	34.	4.	8.	56.	28.	25.
5	843	34.	2.	15.	183.	73.	3.
5	844	160.	20.	27.	266.	133.	25.
5	845	106.	7.	46.	565.	226.	25.
5	846	157.	94.	2250.	21583.	4441.	3.
5	847	20.	12.	675.	4818.	1235.	3.
5	848	13.	8.	287.	4950.	903.	3.
5	849	29.	57.	812.	477.	81.	3.
5	850	2.	5.	68.	42.	7.	3.
5	851	298.	770.	892.	235.	597.	25.
5	858	0.	0.	7.	127.	23.	25.
5	859	0.	0.	0.	0.	350.	3.
5	861	0.	0.	0.	0.	276.	25.

EMISSION SOURCES IN KENDALL COUNTY

COUNTY #	SOURCE #	PM	SOX	NOX	CO	HC	HEIGHT, FT.
6	822	29.	154.	4.	130.	29.	25.
6	823	20.	114.	24.	10.	0.	25.
6	825	5.	0.	13.	5.	2.	25.
6	828	231.	237.	33.	4.	2.	25.
6	831	3.	0.	34.	8.	0.	25.
6	836	16.	112.	43.	0.	2.	25.
6	838	3.	0.	16.	3.	1.	25.
6	840	83.	1.	3.	826.	275.	25.
6	841	38.	2.	13.	178.	71.	3.
6	842	11.	1.	2.	18.	9.	25.
6	843	11.	1.	4.	59.	24.	3.
6	844	34.	4.	6.	57.	28.	25.
6	845	23.	1.	9.	123.	49.	25.
6	846	45.	27.	639.	6200.	1204.	3.
6	847	6.	3.	192.	1378.	353.	3.
6	848	10.	6.	213.	3666.	669.	3.
6	849	8.	10.	231.	136.	23.	3.
6	850	1.	1.	18.	11.	2.	3.
6	851	1.	2.	2.	2.	1.	25.
6	859	0.	0.	0.	0.	141.	3.
6	861	0.	0.	0.	0.	74.	25.

EMISSION SOURCES IN LAKE, IL COUNTY

COUNTY #	SOURCE #	PM	SOX	NOX	CO	HC	HEIGHT, FT.
7	8	236.	3970.	1170.	39.	12.	400.
7	8	236.	3970.	1170.	39.	12.	400.
7	8	236.	3970.	1170.	39.	12.	400.

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7      8    338.   3570.   1170.    38.    12.       400.
7      9    363.   3578.    702.    39.    12.       400.
7      9    116.   3750.    263.    37.    11.       450.
7      9     51.   1650.    292.    16.     5.       450.
7     10     11.   2670.   1600.    29.     9.       330.
7     10     36.   3970.   2140.    39.    12.       400.
7     36     10.     19.    127.     4.     2.        33.
7     36     10.     19.    127.     4.     2.        33.
7     36     10.     19.    127.     4.     2.        33.
7     36     10.     19.    127.     4.     2.        33.
7     72     16.    479.    165.    11.     3.       160.
7     73    114.    129.     15.     2.     1.       180.
7     73    683.    380.     97.    13.     6.       206.
7     73     88.    506.    166.    22.    11.       100.
7     73     86.    494.    162.    22.    11.       100.
7     73     12.     71.     23.     3.     2.       100.
7     73     22.    129.     42.     6.     3.       100.
7     73    319.    129.     42.     6.     3.       160.
7     73    195.     79.     26.     3.     2.        80.
7     73    183.     74.     24.     3.     2.        80.
7     96     26.    271.     65.     5.     3.        35.
7     97      0.     54.     21.     1.     1.         0.
7     97      1.      2.      3.     1.     1.        42.
7     97     14.     94.     36.     2.     2.        40.
7     97      8.     69.     21.     1.     1.       182.
7     97      3.     24.      9.     1.     1.        32.
7     97      7.     98.     19.     1.     1.       120.
7    103      2.      1.     30.     2.     1.        40.
7    103      1.      1.      6.     1.     1.        66.
7    103     26.      1.    330.    24.     4.         0.
7    103      3.      1.     34.     3.     1.        30.
7    103      4.      1.     30.     4.     1.       180.
7    103      7.      1.     84.     6.     1.        90.
7    103     12.      1.    149.    11.     2.       206.
7    103      2.      1.     27.     2.     1.       182.
7    103      1.      1.     16.     1.     1.        32.
7    103      1.      1.      9.     1.     1.        60.
7    103      3.      1.     41.     3.     1.       101.
7    103      3.      1.     41.     3.     1.       101.
7    103      1.      1.     10.     1.     1.       120.
7    149      1.      3.      1.     1.     1.         0.
7    149      1.      2.      1.     1.     1.         0.
7    151      1.      3.      1.     1.     1.         0.
7    152      1.      3.      1.     1.     1.         0.
7    152      1.      4.      2.     1.     1.         0.
7    152      1.      2.      1.     1.     1.         0.
7    152      1.      2.      1.     1.     1.         0.
7    152      1.      3.      1.     1.     1.         0.
7    152      1.      4.      2.     1.     1.         0.
7    152      1.      8.      3.     1.     1.         0.
7    153      3.      1.     36.     3.     1.         0.
7    237      0.      0.      0.     0.    34.        40.
7    333      0.      0.      0.     0.    34.        40.
7    475      2.      0.      0.     0.     0.        20.
7    523     23.      0.      0.     0.     0.         0.
7    527     55.      0.      0.     0.     0.        42.
7    527    299.      0.      0.     0.     0.        40.
7    528    750.      0.      0.     0.     0.        30.
7    582     47.      0.      0.     0.     0.       101.
7    582     47.      0.      0.     0.     0.       101.
7    569      5.      0.      0.     0.     0.        66.
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7	605	42.	0.	0.	0.	0.	47.
7	743	0.	0.	0.	0.	98.	35.
7	743	0.	0.	0.	0.	96.	15.
7	749	0.	0.	0.	0.	41704.	30.
7	822	214.	1136.	32.	961.	214.	25.
7	823	448.	[illegible]	538.	224.	135.	25.
7	825	159.	[illegible]	417.	167.	67.	25.
7	826	2.	0.	1.	0.	0.	25.
7	828	3828.	3410.	552.	74.	37.	25.
7	829	37.	254.	97.	0.	5.	25.
7	830	30.	[illegible]	119.	0.	6.	25.
7	831	27.	2.	271.	1.	127.	25.
7	836	239.	1628.	622.	2.	31.	25.
7	838	45.	1.	233.	48.	19.	25.
7	840	399.	7.	13.	3994.	1331.	25.
7	841	108.	15.	61.	271.	348.	3.
7	842	53.	7.	9.	89.	44.	25.
7	843	54.	3.	20.	289.	110.	3.
7	844	1005.	126.	167.	1675.	837.	25.
7	845	670.	42.	221.	3557.	1423.	25.
7	846	603.	302.	6639.	64530.	17083.	3.
7	847	78.	47.	2593.	18511.	4760.	3.
7	848	5.	3.	117.	2016.	368.	3.
7	849	110.	220.	2116.	1833.	312.	3.
7	850	9.	20.	270.	164.	27.	3.
7	851	161.	263.	304.	283.	202.	25.
7	852	17.	3.	8.	42.	39.	25.
7	856	2.	3.	[illegible]	[illegible]	3.	25.
7	858	19.	12.	418.	7204.	1315.	25.
7	859	0.	0.	0.	0.	1536.	3.
7	861	0.	0.	0.	0.	2044.	25.

EMISSICN SGURCES IN MCHENRY COUNTY

COUNTY #	SOURCE #	PM	SOX	NOX	CO	HC	HEIGHT, FT.
8	57	1.	18.	3.	1.	1.	25.
8	103	1.	1.	3.	1.	1.	50.
8	103	2.	1.	15.	1.	1.	25.
8	743	0.	0.	0.	0.	98.	30.
8	743	0.	0.	0.	0.	2.	25.
8	743	0.	0.	0.	0.	7.	25.
8	822	65.	348.	10.	295.	65.	25.
8	823	101.	571.	121.	50.	30.	25.
8	825	31.	1.	81.	32.	13.	25.
8	828	1533.	1970.	221.	30.	15.	25.
8	829	15.	102.	35.	0.	2.	25.
8	830	12.	45.	48.	0.	2.	25.
8	831	23.	1.	229.	1.	51.	25.
8	836	[illegible]	474.	101.	1.	9.	25.
8	838	13.	0.	65.	14.	6.	25.
8	840	524.	9.	17.	5241.	1747.	25.
8	841	215.	13.	81.	1143.	457.	3.
8	842	70.	4.	12.	116.	50.	25.
8	843	71.	4.	27.	378.	151.	3.
8	844	37.	5.	6.	61.	30.	25.
8	845	24.	1.	9.	127.	51.	25.
8	846	191.	115.	2744.	20113.	5347.	3.
8	847	25.	15.	824.	5729.	1484.	3.

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     8        848      15.       9.     316.    5406.    1004.                3.
     8        849      35.      73.     990.     582.      95.                3.
     8        850       3.       6.      78.      47.       0.                3.
     8        851      41.     106.     122.     114.      81.               25.
     8        858       1.       0.      14.     233.      43.               25.
     8        859       0.       0.       0.       0.     490.                3.
     8        861       0.       0.       0.       0.     594.               25.

                   EMISSION SOURCES IN WILL      COUNTY

COUNTY #  SOURCE #      PM      SOX      NOX       CO       HC  HEIGHT. FT.

     9          9      26.     843.     117.       6.       2.          500.
     9          9     220.    4400.     620.      34.      10.          440.
     9          9     132.    3060.     404.      22.       7.          550.
     9          9     132.    3060.     404.      22.       7.          550.
     9          9     115.    2370.     312.      17.       5.          550.
     9          9      48.    2980.     371.      22.       7.          550.
     9         10      61.    3050.    1350.      25.       7.          349.
     9         10      53.    2610.    1230.      22.       7.          349.
     9         10      30.    5120.    2080.      38.      11.          450.
     9         10       3.     827.     338.       6.       2.          248.
     9         10       6.     827.     338.       6.       2.          248.
     9         36       5.      45.      61.       2.       1.           30.
     9         36      46.     451.     603.      17.      11.           30.
     9         37       2.      70.      25.       1.       1.           30.
     9         42      10.       1.     419.      12.       1.           30.
     9         42       1.       2.    1740.      49.       3.          550.
     9         42       1.       2.    1740.      49.       3.          550.
     9         42       1.       2.    1620.      46.       3.          550.
     9         42       1.       2.    1620.      46.       3.          550.
     9         42       1.       1.      29.       1.       1.          248.
     9         43       2.       1.      38.       3.       1.           50.
     9         68     319.     475.      90.       9.       2.          220.
     9         68     535.     652.     103.      14.       7.           78.
     9         68      37.     652.     103.      14.       7.           70.
     9         68     307.    1380.     242.      32.      16.          150.
     9         68     307.    1380.     242.      32.      16.          150.
     9         68     224.    1000.     176.      24.      12.          125.
     9         72    2460.     969.     255.      14.       4.          119.
     9         72    2460.     971.     255.      14.       4.          119.
     9         72    2460.     971.     255.      14.       4.          119.
     9         73       4.      51.      81.      11.       5.           78.
     9         73      29.     512.      81.      11.       5.           78.
     9         95       6.      32.      14.       1.       1.           75.
     9         96       8.      30.      14.       1.       1.           50.
     9         97       9.      90.      23.       2.       1.           18.
     9         97       6.      57.      14.       1.       1.            0.
     9         97      23.     236.      60.       4.       3.          156.
     9         97       6.      32.      14.       1.       1.           50.
     9         97       6.      32.      14.       1.       1.           50.
     9         97       6.      32.      14.       1.       1.           50.
     9         97       6.      32.      14.       1.       1.           50.
     9         97       6.      70.      14.       1.       1.           50.
     9         97       6.      70.      14.       1.       1.           50.
     9         97       6.      70.      14.       1.       1.           50.
     9         97       6.      70.      14.       1.       1.           50.
     9         97       3.      13.       6.       1.       1.           37.
     9         97      13.      54.      34.       2.       2.           28.
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    9      97      6.     43.     15.      1.      1.        35.
    9      97      4.     29.     10.      1.      1.        75.
    9      97      8.     58.     20.      1.      1.       100.
    9      97      1.      7.      2.      1.      1.        85.
    9      97     29.    394.     75.      5.      4.        50.
    9      97     77.   1270.    202.     13.     10.        35.
    9      97     77.   1270.    202.     13.     10.        70.
    9      97     77.   1270.    202.     13.     10.        70.
    9      97     77.   1270.    202.     13.     10.        70.
    9      97     77.   1270.    202.     13.     10.        50.
    9      97      3.     57.      9.      1.      1.        39.
    9      97      1.      2.      3.      1.      1.        33.
    9     102      3.      1.     38.      3.      1.        75.
    9     102      3.      1.     38.      3.      1.        50.
    9     102     10.      1.    127.      9.      2.       125.
    9     102      5.      1.     64.      5.      1.        46.
    9     103      1.      1.      9.      1.      1.        30.
    9     103      1.      1.     18.      1.      1.         0.
    9     103      5.      1.     58.      4.      1.       156.
    9     103      7.      1.     88.      6.      1.       120.
    9     103     10.      1.    126.      9.      2.       120.
    9     103      6.      1.     71.      5.      1.       140.
    9     103      6.      1.     73.      5.      1.        92.
    9     103      2.      1.     22.      2.      1.        77.
    9     103      1.      1.     18.      1.      1.        50.
    9     103      6.      1.     74.      5.      1.        50.
    9     103      2.      1.     27.      2.      1.        55.
    9     103      5.      1.     66.      5.      1.       135.
    9     103      5.      1.     66.      5.      1.       135.
    9     103      3.      1.     38.      3.      1.        50.
    9     103      3.      1.     38.      3.      1.        50.
    9     103      3.      1.     38.      3.      1.        50.
    9     103      3.      1.     38.      3.      1.        50.
    9     103      3.      1.     38.      3.      1.        50.
    9     103      3.      1.     38.      3.      1.        50.
    9     103      3.      1.     38.      3.      1.        50.
    9     103      3.      1.     38.      3.      1.        50.
    9     103      1.      1.     12.      1.      1.        85.
    9     103      2.      1.     26.      2.      1.       100.
    9     103      2.      1.     26.      2.      1.       100.
    9     103      5.      1.     59.      4.      1.       100.
    9     103      5.      1.     59.      4.      1.        70.
    9     103      9.      1.    117.      9.      2.       100.
    9     103      9.      1.    115.      9.      2.        85.
    9     103      3.      1.     38.      3.      1.        50.
    9     103      4.      1.     51.      4.      1.        35.
    9     103      4.      1.     51.      4.      1.        70.
    9     103      4.      1.     51.      4.      1.        70.
    9     103      4.      1.     51.      4.      1.        70.
    9     103      4.      1.     51.      4.      1.        50.
    9     103      3.      1.     37.      3.      1.        39.
    9     103      1.      1.     15.      1.      1.        33.
    9     104      7.      1.     44.      6.      1.         0.
    9     104      1.      1.      4.      1.      1.        25.
    9     104      1.      1.      4.      1.      1.       100.
    9     128    133.    475.     72.     10.      5.       220.
    9     136    139.    166.     26.      4.      1.       150.
    9     136    139.    166.     26.      4.      1.       150.
    9     152     43.    405.    171.     11.      0.         0.
    9     152      0.     66.      0.      0.      0.         0.
    9     152     45.    341.    180.     12.      0.         0.
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9     208      0.      0.   7060.      0.      0.       40.
9     209      0.      0.     44.      0.      0.       51.
9     210      1.    745.      0.      0.      0.       32.
9     211   1590.    574.    265.      0.      0.       80.
9     221      0.      0.   2290.      0.      0.       55.
9     262     72.    779.      0.      0.      0.      100.
9     263     63.   1000.      0.      0.      0.       40.
9     263     84.   1340.      0.      0.      0.       40.
9     473      6.      0.      0.      0.      0.       20.
9     477     13.      0.      0.    106.      0.       25.
9     522    258.      0.      0.     93.    155.       64.
9     523    132.      0.      0.      0.      0.       70.
9     610    375.      0.      0.      0.      0.       40.
9     610    500.      0.      0.      0.      0.       40.
9     610    250.      0.      0.      0.      0.       40.
9     610    157.      0.      0.      0.      0.       10.
9     610     75.      0.      0.      0.      0.       40.
9     611   1120.      0.      0.      0.      0.       40.
9     611    375.      0.      0.      0.      0.       40.
9     611    749.      0.      0.      0.      0.       40.
9     611    562.      0.      0.      0.      0.       10.
9     611    225.      0.      0.      0.      0.       40.
9     612   4500.      0.      0.      0.      0.       40.
9     612   5400.      0.      0.      0.      0.       40.
9     612   5830.      0.      0.      0.      0.       40.
9     612   2230.      0.      0.      0.      0.       10.
9     614    899.      0.      0.      0.      0.       40.
9     615   1540.      0.      0.      0.      0.       40.
9     615    740.      0.      0.      0.      0.       10.
9     615    300.      0.      0.      0.      0.       40.
9     616    800.      0.      0.      0.      0.       40.
9     616   1500.      0.      0.      0.      0.       40.
9     616   9720.      0.      0.      0.      0.       40.
9     616   3740.      0.      0.      0.      0.       20.
9     616   1500.      0.      0.      0.      0.       40.
9     637   1330.   2700.    389.  75000.   1200.      194.
9     639      0.      0.      0.      0.     69.        5.
9     642      0.      0.      0.      0.   3280.        1.
9     645      0.      0.      0.      0.   3000.       20.
9     646      0.      0.      0.      0.    389.        3.
9     647      0.      0.      0.      0.    153.       20.
9     648      0.      0.      0.      0.    236.        2.
9     649      0.      0.      0.      0.     69.       10.
9     743      0.      0.      0.      0.    491.       19.
9     743      0.      0.      0.      0.     98.       30.
9     743      0.      0.      0.      0.      7.       60.
9     749      0.      0.      0.      0.     20.       60.
9     749      0.      0.      0.      0.     20.       60.
9     749      0.      0.      0.      0.    108.       60.
9     749      0.      0.      0.      0.    316.       60.
9     749      0.      0.      0.      0.     28.       60.
9     749      0.      0.      0.      0.      9.       60.
9     749      0.      0.      0.      0.      4.       60.
9     749      0.      0.      0.      0.      4.       60.
9     749      0.      0.      0.      0.    253.       60.
9     749      0.      0.      0.      0.      4.       60.
9     749      0.      0.      0.      0.      4.       60.
9     749      0.      0.      0.      0.     19.       60.
9     749      0.      0.      0.      0.      4.       60.
9     749      0.      0.      0.      0.      4.       60.
9     749      0.      0.      0.      0.     25.       60.
```

DEI
310

9	749	0.	0.	0.	0.	3.	60.
9	749	0.	0.	0.	0.	3.	60.
9	749	0.	0.	0.	0.	3.	60.
9	749	0.	0.	0.	0.	3.	60.
9	749	0.	0.	0.	0.	3.	60.
9	749	0.	0.	0.	0.	11.	60.
9	749	0.	0.	0.	0.	11.	60.
9	749	0.	0.	0.	0.	4.	60.
9	749	0.	0.	0.	0.	4.	60.
9	749	0.	0.	0.	0.	67.	60.
9	749	0.	0.	0.	0.	99.	60.
9	749	0.	0.	0.	0.	9.	60.
9	749	0.	0.	0.	0.	9.	60.
9	749	0.	0.	0.	0.	67.	60.
9	749	0.	0.	0.	0.	16.	60.
9	749	0.	0.	0.	0.	138.	60.
9	749	0.	0.	0.	0.	55.	60.
9	749	0.	0.	0.	0.	25.	60.
9	749	0.	0.	0.	0.	25.	60.
9	749	0.	0.	0.	0.	4.	60.
9	749	0.	0.	0.	0.	2.	60.
9	749	0.	0.	0.	0.	4.	60.
9	749	0.	0.	0.	0.	20.	60.
9	749	0.	0.	0.	0.	20.	60.
9	749	0.	0.	0.	0.	3.	60.
9	749	0.	0.	0.	0.	4.	60.
9	749	0.	0.	0.	0.	6.	60.
9	749	0.	0.	0.	0.	202.	60.
9	749	0.	0.	0.	0.	202.	60.
9	749	0.	0.	0.	0.	42.	60.
9	749	0.	0.	0.	0.	42.	60.
9	749	0.	0.	0.	0.	42.	60.
9	749	0.	0.	0.	0.	108.	60.
9	749	0.	0.	0.	0.	108.	60.
9	749	0.	0.	0.	0.	307.	60.
9	749	0.	0.	0.	0.	307.	60.
9	749	0.	0.	0.	0.	307.	60.
9	749	0.	0.	0.	0.	22.	60.
9	749	0.	0.	0.	0.	22.	60.
9	749	0.	0.	0.	0.	7.	60.
9	749	0.	0.	0.	0.	7.	60.
9	749	0.	0.	0.	0.	7.	60.
9	749	0.	0.	0.	0.	4.	60.
9	749	0.	0.	0.	0.	4.	60.
9	749	0.	0.	0.	0.	19.	60.
9	749	0.	0.	0.	0.	14.	60.
9	749	0.	0.	0.	0.	75.	60.
9	749	0.	0.	0.	0.	20.	60.
9	749	0.	0.	0.	0.	3.	60.
9	749	0.	0.	0.	0.	75.	60.
9	749	0.	0.	0.	0.	75.	60.
9	749	0.	0.	0.	0.	65.	60.
9	749	0.	0.	0.	0.	25.	60.
9	749	0.	0.	0.	0.	24.	60.
9	749	0.	0.	0.	0.	78.	60.
9	749	0.	0.	0.	0.	34.	60.
9	749	0.	0.	0.	0.	81.	60.
9	749	0.	0.	0.	0.	129.	60.
9	749	0.	0.	0.	0.	169.	60.
9	749	0.	0.	0.	0.	203.	60.
9	749	0.	0.	0.	0.	494.	60.

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9     743    0.     0.     0.     0.     523.       100.
9     749    0.     0.     0.     0.     262.       100.
9     749    0.     0.     0.     0.     129.       100.
9     749    0.     0.     0.     0.     258.       100.
9     749    0.     0.     0.     0.     131.       100.
9     749    0.     0.     0.     0.     290.       100.
9     749    0.     0.     0.     0.     129.       100.
9     749    0.     0.     0.     0.     293.       100.
9     749    0.     0.     0.     0.     562.       100.
9     749    0.     0.     0.     0.     112.       100.
9     749    0.     0.     0.     0.      40.       100.
9     749    0.     0.     0.     0.      79.       100.
9     749    0.     0.     0.     0.      40.       100.
9     749    0.     0.     0.     0.      82.       100.
9     749    0.     0.     0.     0.       9.       100.
9     749    0.     0.     0.     0.      12.       100.
9     749    0.     0.     0.     0.      56.       100.
9     749    0.     0.     0.     0.      21.       100.
9     749    0.     0.     0.     0.     238.       100.
9     749    0.     0.     0.     0.      37.       100.
9     749    0.     0.     0.     0.      17.       100.
9     749    0.     0.     0.     0.       4.       100.
9     749    0.     0.     0.     0.      11.       100.
9     750    0.     0.     0.     0.     209.        60.
9     750    0.     0.     0.     0.      94.        60.
9     750    0.     0.     0.     0.     136.        60.
9     750    0.     0.     0.     0.     138.        60.
9     750    0.     0.     0.     0.      51.        60.
9     750    0.     0.     0.     0.      51.        60.
9     750    0.     0.     0.     0.     201.       100.
9     750    0.     0.     0.     0.     238.       100.
9     750    0.     0.     0.     0.     517.       100.
9     751    0.     0.     0.     0.      19.        60.
9     751    0.     0.     0.     0.      26.        60.
9     751    0.     0.     0.     0.     110.        60.
9     751    0.     0.     0.     0.     121.        60.
9     751    0.     0.     0.     0.     142.        60.
9     751    0.     0.     0.     0.      38.        60.
9     751    0.     0.     0.     0.     100.        60.
9     751    0.     0.     0.     0.    1080.        60.
9     751    0.     0.     0.     0.     884.        60.
9     751    0.     0.     0.     0.    1420.        60.
9     751    0.     0.     0.     0.      12.        60.
9     751    0.     0.     0.     0.      12.        60.
9     751    0.     0.     0.     0.     137.        60.
9     751    0.     0.     0.     0.      21.        60.
9     751    0.     0.     0.     0.      67.        60.
9     751    0.     0.     0.     0.      67.        60.
9     751    0.     0.     0.     0.      29.        60.
9     751    0.     0.     0.     0.     170.        60.
9     751    0.     0.     0.     0.     180.        60.
9     751    0.     0.     0.     0.     167.        60.
9     751    0.     0.     0.     0.     180.        60.
9     751    0.     0.     0.     0.     572.        60.
9     751    0.     0.     0.     0.       7.        60.
9     751    0.     0.     0.     0.      11.        60.
9     751    0.     0.     0.     0.      60.        60.
9     751    0.     0.     0.     0.      89.        60.
9     751    0.     0.     0.     0.      10.        60.
9     751    0.     0.     0.     0.      10.        60.
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```
9   751   0.   0.   0.   0.    126.       60.
9   751   0.   0.   0.   0.     64.       60.
9   751   0.   0.   0.   0.    310.       60.
9   751   0.   0.   0.   0.    305.       60.
9   751   0.   0.   0.   0.     24.       60.
9   751   0.   0.   0.   0.     29.       60.
9   751   0.   0.   0.   0.      4.       60.
9   751   0.   0.   0.   0.   1600.       60.
9   751   0.   0.   0.   0.      5.       60.
9   751   0.   0.   0.   0.     66.       60.
9   751   0.   0.   0.   0.     66.       60.
9   751   0.   0.   0.   0.      3.       60.
9   751   0.   0.   0.   0.     11.       60.
9   751   0.   0.   0.   0.    598.       60.
9   751   0.   0.   0.   0.    598.       60.
9   751   0.   0.   0.   0.    142.       60.
9   751   0.   0.   0.   0.    142.       60.
9   751   0.   0.   0.   0.    142.       60.
9   751   0.   0.   0.   0.     73.       60.
9   751   0.   0.   0.   0.    121.       60.
9   751   0.   0.   0.   0.    137.       60.
9   751   0.   0.   0.   0.    172.       60.
9   751   0.   0.   0.   0.     30.       60.
9   751   0.   0.   0.   0.     30.       60.
9   751   0.   0.   0.   0.      9.       60.
9   751   0.   0.   0.   0.      5.       60.
9   751   0.   0.   0.   0.     15.       60.
9   751   0.   0.   0.   0.      9.       60.
9   751   0.   0.   0.   0.    506.       60.
9   751   0.   0.   0.   0.    107.       60.
9   751   0.   0.   0.   0.      9.       60.
9   751   0.   0.   0.   0.     83.       60.
9   751   0.   0.   0.   0.      2.       60.
9   751   0.   0.   0.   0.      3.       60.
9   751   0.   0.   0.   0.    185.       60.
9   751   0.   0.   0.   0.    202.       60.
9   751   0.   0.   0.   0.     44.       60.
9   751   0.   0.   0.   0.    225.       60.
9   751   0.   0.   0.   0.     11.       60.
9   751   0.   0.   0.   0.     67.       60.
9   751   0.   0.   0.   0.     26.       60.
9   751   0.   0.   0.   0.    104.       60.
9   751   0.   0.   0.   0.    173.       60.
9   751   0.   0.   0.   0.    330.       60.
9   751   0.   0.   0.   0.   8400.       60.
9   751   0.   0.   0.   0.      8.      100.
9   751   0.   0.   0.   0.   1050.      100.
9   751   0.   0.   0.   0.    200.      100.
9   751   0.   0.   0.   0.   1390.      100.
9   751   0.   0.   0.   0.    195.      100.
9   751   0.   0.   0.   0.    390.      100.
9   751   0.   0.   0.   0.    284.      100.
9   751   0.   0.   0.   0.    838.      100.
9   751   0.   0.   0.   0.    524.      100.
9   751   0.   0.   0.   0.    881.      100.
9   751   0.   0.   0.   0.     44.      100.
9   751   0.   0.   0.   0.    544.      100.
9   751   0.   0.   0.   0.     26.      100.
9   751   0.   0.   0.   0.    110.      100.
9   751   0.   0.   0.   0.      6.      100.
9   751   0.   0.   0.   0.     16.      100.
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9	751	0.	0.	0.	0.	229.	100.
9	751	0.	0.	0.	0.	47.	100.
9	751	0.	0.	0.	0.	232.	100.
9	751	0.	0.	0.	0.	848.	100.
9	751	0.	0.	0.	0.	2310.	100.
9	751	0.	0.	0.	0.	327.	100.
9	751	0.	0.	0.	0.	2480.	100.
9	752	0.	0.	0.	0.	187.	60.
9	752	0.	0.	0.	0.	50.	60.
9	752	0.	0.	0.	0.	37.	60.
9	752	0.	0.	0.	0.	735.	60.
9	752	0.	0.	0.	0.	27.	60.
9	752	0.	0.	0.	0.	27.	60.
9	752	0.	0.	0.	0.	981.	100.
9	752	0.	0.	0.	0.	206.	100.
9	762	53.	9.	7.	70.	33.	37.
9	796	13.	2.	2.	18.	13.	125.
9	796	7.	1.	1.	6.	7.	39.
9	797	2.	2.	13.	0.	0.	125.
9	822	423.	2232.	83.	1902.	423.	25.
9	823	164.	932.	157.	82.	49.	25.
9	825	62.	2.	164.	66.	26.	25.
9	826	7.	0.	3.	1.	1.	25.
9	828	2763.	2847.	401.	54.	27.	25.
9	829	27.	134.	70.	0.	4.	25.
9	830	22.	82.	87.	0.	4.	25.
9	831	42.	1.	416.	1.	92.	25.
9	836	155.	1061.	466.	1.	20.	25.
9	838	29.	1.	155.	31.	12.	25.
9	840	391.	7.	13.	3907.	1302.	25.
9	841	160.	10.	66.	850.	340.	3.
9	842	32.	7.	9.	87.	43.	25.
9	843	54.	3.	26.	285.	114.	3.
9	844	57.	72.	96.	956.	470.	25.
9	845	382.	24.	143.	2031.	813.	25.
9	846	226.	316.	7542.	73165.	15035.	3.
9	847	68.	41.	2264.	16403.	4188.	3.
9	848	15.	9.	315.	5499.	1004.	3.
9	849	96.	192.	2721.	1600.	272.	3.
9	850	0.	13.	170.	107.	18.	3.
9	851	74.	191.	221.	206.	147.	25.
9	856	9.	24.	28.	26.	19.	25.
9	857	10.	43.	26.	0.	1.	25.
9	858	1.	0.	10.	273.	50.	25.
9	859	0.	0.	0.	0.	1183.	3.
9	861	0.	0.	0.	0.	1332.	25.

EMISSION SOURCES IN LAKE, IN COUNTY

COUNTY #	SOURCE #	PM	SOX	NOX	CO	HC	HEIGHT, FT.
10	9	545.	20900.	463.	171.	51.	236.
10	9	545.	26900.	463.	165.	50.	236.
10	9	203.	3050.	403.	22.	7.	307.
10	9	203.	3050.	403.	22.	7.	307.
10	9	306.	4580.	606.	34.	10.	307.
10	9	306.	4580.	606.	34.	10.	307.
10	9	306.	4580.	606.	34.	10.	307.
10	9	322.	12300.	230.	102.	31.	236.

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10     9   643.  25500.   431.   183.    35.        236.
10     9   157.  23700.  3400.   185.    37.        456.
10     9   644.  36400.  4810.   207.    80.        406.
10     9   492.   8500.  1120.    62.    19.        307.
10     9   462.   8500.  1120.    62.    19.        307.
10     9   462.   8500.  1120.    62.    19.        307.
10     9   203.   3050.   403.    22.     7.        307.
10    18    75.   3340.   987.    28.    19.        186.
10    35    75.   3340.   987.    28.    19.        146.
10    36    75.   3340.   987.    28.    19.        186.
10    34    88.   3870.  1150.    33.    22.        179.
10    42     0.      0.     3.     1.     1.        450.
10    45    17.   1650.   985.     0.    38.        186.
10    45    17.   1660.   985.     0.    38.        186.
10    45    12.   1240.  1140.     0.    26.        179.
10    66   722.   3380.   344.    30.     9.        170.
10    66  2140.   1410.   231.    13.     4.        170.
10    66  2140.   1410.   231.    13.     4.        170.
10    66  2140.   1410.   231.    13.     4.        170.
10    66  1250.    829.   135.     8.     2.        150.
10    66  1230.    829.   135.     8.     2.        150.
10    66  1040.    691.   113.     6.     2.        150.
10    66  1040.    691.   113.     6.     2.        150.
10    66  4370.  15100.  2830.   157.    47.          0.
10    66  4370.  15100.  2830.   157.    47.          0.
10    66  4370.  15100.  2830.   157.    47.          0.
10    66  4370.  15100.  2830.   157.    47.          0.
10    68   234.   1640.   230.    31.    15.        103.
10    68   236.   1320.   213.    28.    14.        103.
10    68   236.   1520.   213.    28.    14.        103.
10    72   181.   2250.   337.    19.     6.         85.
10    72   181.   2250.   337.    19.     6.         85.
10    72   181.   2250.   337.    19.     6.         85.
10    73  3680.   3160.   443.    55.    30.         86.
10    73  3680.   3160.   443.    59.    30.         86.
10    73   111.    281.    12.     2.     1.         43.
10    73   203.    319.    45.     6.     3.         77.
10    96    19.    165.    50.     3.     3.        150.
10    96    18.    617.   212.    21.    16.        170.
10    96    20.    344.   131.     9.     7.        170.
10    96    50.    344.   131.     9.     7.        170.
10    96    50.    344.   131.     9.     7.        170.
10    96    30.    202.    77.     5.     4.        150.
10    96    30.    202.    77.     5.     4.        180.
10    96    25.    168.    64.     4.     3.        150.
10    96    25.    168.    64.     4.     3.        150.
10    96     5.     27.    13.     0.     1.        150.
10    96     5.     27.    13.     0.     1.        180.
10    96     5.     27.    13.     0.     1.        150.
10    96     5.     27.    13.     0.     1.        150.
10    96    24.    177.    61.     4.     3.          0.
10    96    36.    703.   145.    10.     7.         59.
10    96     5.     27.    13.     0.     1.        150.
10    96    24.    177.    61.     4.     3.          0.
10    96    24.    177.    61.     4.     3.          0.
10    96    24.    177.    61.     4.     3.          0.
10    96    28.    212.    74.     0.     4.          0.
10    96   601.  12600.  1570.   105.    78.        200.
10    96    20.    201.    95.     3.     3.        120.
10    96    21.    202.    94.     4.     3.        160.
10    96    44.   1170.   114.     8.     6.        175.
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10      96    41.   1333.   155.   11.    8.        175.
10      96    20.   1090.   157.   10.    8.        168.
10      96    16.   1460.    41.    3.    2.        195.
10      96    52.   1170.   135.    9.    7.        132.
10      96    87.   1340.   227.   15.   11.        190.
10      96    19.    272.    50.    3.    2.        160.
10      96    31.    473.    86.    5.    4.         50.
10      96   177.    728.   482.   31.   23.        179.
10      96    88.   1670.   231.   15.   12.        190.
10      96    31.    402.    81.    5.    4.        166.
10      96   257.   4540.   670.   45.   33.        179.
10      96   227.  11803.  1716.  174.   88.        180.
10      97     1.     17.     3.    1.    1.         43.
10      97    23.    361.    86.    4.    3.         51.
10      97    23.    420.    55.    4.    3.         51.
10      97    87.   1030.   172.   12.    9.         44.
10      97    24.    326.    61.    4.    3.        150.
10      97    19.    354.    51.    3.    3.        160.
10      98     7.    115.    18.    1.    1.        153.
10      98     7.    115.    18.    1.    1.        153.
10      98     7.    115.    18.    1.    1.        153.
10      98     7.    115.    18.    1.    1.        153.
10      99     6.     40.    24.    2.    1.        116.
10      99     6.     46.    24.    2.    1.        116.
10      99     6.     46.    24.    2.    1.        116.
10      99    11.    128.    43.    3.    2.         64.
10      99    38.    826.   152.   10.    8.        165.
10     100     3.     45.    12.    1.    1.         60.
10     101     7.     27.    25.    2.    1.         70.
10     101     3.     44.    10.    1.    1.         65.
10     101     2.     53.     8.    1.    1.         51.
10     102     1.      1.     7.    1.    1.        170.
10     102     1.      1.     7.    1.    1.        170.
10     102     1.      1.     7.    1.    1.        170.
10     102     1.      1.     7.    1.    1.        170.
10     102     1.      1.     4.    1.    1.        150.
10     102     1.      1.     4.    1.    1.        150.
10     102     1.      1.     4.    1.    1.        150.
10     102     1.      1.     4.    1.    1.        150.
10     102    20.      1.   252.   19.    3.         84.
10     102    10.      0.   131.   10.    2.        150.
10     102     1.      1.    11.    1.    1.        119.
10     102    20.      1.   255.   19.    3.        125.
10     102    20.      1.   255.   19.    3.        125.
10     103     2.      1.    25.    2.    1.        215.
10     103    35.      1.   486.   34.    6.         46.
10     103     4.      1.    47.    4.    1.         26.
10     103     1.      1.    11.    1.    1.        130.
10     104     2.      1.    16.    2.    1.        153.
10     104     2.      1.    16.    2.    1.        153.
10     104     2.      1.    16.    2.    1.        153.
10     104     2.      1.    16.    2.    1.        154.
10     105     3.    109.    47.    3.    1.        150.
10     105     3.    720.   311.   23.    4.        170.
10     105     9.    303.   131.   10.    2.        170.
10     105     9.    303.   131.   10.    2.        170.
10     105     9.    303.   131.   10.    2.        170.
10     105     5.    178.    77.    6.    1.        150.
10     105     5.    178.    77.    6.    1.        150.
10     105     4.    148.    64.    5.    1.        150.
10     105     4.    148.    64.    5.    1.        150.
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10        105    147.      0.   2250.    166.     29.          116.
10        105    147.      0.   2250.    166.     29.          116.
10        105    147.      0.   2250.    166.     29.          116.
10        105     12.    601.    188.     14.      2.          103.
10        105     12.    601.    188.     14.      2.          103.
10        105     12.    601.    188.     14.      2.          103.
10        105    152.      0.   2320.      0.     30.          150.
10        105    152.      0.   2320.      0.     30.          150.
10        105    152.      0.   2320.      0.     30.          150.
10        105    152.      0.   2320.      0.     30.          150.
10        105    152.      0.   2320.      0.     30.          150.
10        105      1.      0.      9.      0.      1.            0.
10        105      4.   1020.     65.      5.      1.           59.
10        105      1.      0.      8.      1.      1.            0.
10        105      1.      0.      8.      1.      1.            0.
10        105      1.      0.      8.      1.      1.            0.
10        105      1.      0.      8.      1.      1.            0.
10        105      1.      8.      1.      0.      1.            0.
10        105      1.      0.      4.      0.      1.            0.
10        105     72.   2171.   2557.    722.     76.          150.
10        105      1.     28.      2.      1.      1.          266.
10        105      1.    127.     21.      2.      1.          110.
10        105      4.    464.     87.      5.      1.          175.
10        105      4.    657.     88.      5.      1.          175.
10        105      5.    346.     78.      6.      1.           55.
10        105      5.    346.     78.      6.      1.          125.
10        105      5.    346.     78.      6.      1.          125.
10        105      6.    425.     90.      7.      1.          125.
10        105      6.    425.     90.      7.      1.          125.
10        105     15.    466.    103.      0.     34.            0.
10        105      9.    772.    144.     11.      2.          190.
10        105      2.    133.     25.      2.      1.          160.
10        105      6.    467.     91.      7.      1.           50.
10        105     20.    735.    306.     23.      4.          195.
10        105      6.    550.     85.      6.      1.          190.
10        105      3.    776.     54.      4.      1.          166.
10        105     10.    907.    147.     11.      2.          179.
10        105     29.   2740.    437.     32.      6.          180.
10        106      5.    311.     73.      0.      1.          150.
10        106      5.    311.     73.      0.      1.          150.
10        106      5.    311.     73.      0.      1.          150.
10        106      5.    311.     73.      0.      1.          150.
10        106      5.    311.     73.      0.      1.          150.
10        106      1.      0.      1.      1.      1.            0.
10        106      1.      6.      1.      1.      1.            0.
10        106      1.      6.      1.      1.      1.            0.
10        106      2.    201.     45.      0.      6.          120.
10        106      2.    201.     45.      0.      6.          120.
10        106      3.    202.     37.      0.      2.          150.
10        106      2.    202.     33.      2.      1.          150.
10        106      5.    436.     73.      5.      1.          175.
10        106      3.    282.     39.      3.      1.          160.
10        106      1.     67.     13.      1.      1.          100.
10        106      1.     93.     15.      1.      1.          100.
10        108     70.   5510.    702.     94.      9.            0.
10        108     70.   5510.    702.     94.      9.            0.
10        108     70.   5510.    702.     94.      9.            0.
10        108     70.   5510.    702.     94.      9.            0.
10        110     16.      1.      6.      1.      1.           10.
10        111     13.      1.      3.      1.      1.           60.
10        112      3.    111.     23.      3.      1.          103.
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10     118     0.    626.     0.     0.     0.         165.
10     205    79.      0.     0.     0.     0.          84.
10     207    50.   5000.     0.     0.     0.         140.
10     268     0.   1300.     0.     0.     0.         220.
10     268     0.   4600.     0.     0.     0.         300.
10     333    31.      0.     0.     0.     0.          56.
10     333     0.      0.     0.     0.    18.          20.
10     333    24.      0.     0.     0.     0.          80.
10     333     2.      0.     0.     0.     0.          50.
10     333    16.      0.     0.     0.     0.          80.
10     354    54.      0.     0.     0.     0.          65.
10     361    30.      0.     0.     0.     0.          20.
10     361   103.      0.     0.     0.     0.          20.
10     361    47.      0.     0.     0.     0.          60.
10     361    30.      0.     0.     0.     0.          40.
10     361   253.      0.     0.     0.     0.          40.
10     361   459.      0.     0.     0.     0.          65.
10     361    45.      0.     0.     0.     0.          65.
10     399  1010.      0.    12.   308.  1220.         100.
10     399  1010.      0.    12.   308.  1220.         100.
10     399  1010.      0.    12.   308.  1220.         100.
10     399   652.      0.    10.   309.  1020.          50.
10     399   634.      0.     7.   230.   761.          50.
10     399   653.      0.    10.   309.  1020.          50.
10     399   634.      0.     7.   230.   761.          50.
10     399   732.      0.     8.   266.   878.          50.
10     399   731.      0.     8.   265.   877.          53.
10     399   732.      0.     8.   266.   878.          50.
10     399   731.      0.     8.   265.   877.          50.
10     399   654.      0.    10.   310.  1020.          50.
10     399   654.      0.    10.   310.  1020.          50.
10     399  1733.      0.    20.   620.  2060.          50.
10     399   513.      0.     6.   186.   616.         100.
10     399  1010.      0.    12.   372.  1230.         100.
10     399  1030.      0.    12.   372.  1230.         100.
10     399  1030.      0.    12.   372.  1230.         100.
10     399  1030.      0.    12.   372.  1230.         100.
10     399  1300.      0.    15.   473.  1560.         100.
10     399  1300.      0.    15.   473.  1560.         100.
10     400   434.      6.     9.   174.   724.         100.
10     400   434.      6.     9.   174.   724.         100.
10     400   434.      6.     9.   174.   724.         100.
10     400    15.     10.    15.     6.    25.         100.
10     400   365.      5.     7.   146.   609.         100.
10     400   272.      4.     5.   109.   453.         100.
10     400   365.      5.     7.   146.   609.         100.
10     400   272.      4.     5.   109.   453.         100.
10     400   314.      4.     6.   126.   523.         100.
10     400   313.      4.     6.   125.   522.         100.
10     400   314.      4.     6.   126.   523.         100.
10     400   313.      4.     6.   125.   522.         100.
10     400   366.      5.     7.   146.   610.         100.
10     400   366.      5.     7.   146.   610.         100.
10     400   220.      3.     4.    88.   367.          75.
10     400   440.      6.     9.   176.   733.          75.
10     400   440.      6.     9.   176.   733.          75.
10     400   440.      6.     9.   176.   733.          75.
10     400   440.      6.     9.   176.   733.          75.
10     400   559.      7.    11.   224.   932.          75.
10     400   559.      7.    11.   224.   932.          75.
10     401   174.      0.     0.    20.    58.         100.
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10	401	174.	0.	0.	20.	58.	100.
10	401	174.	0.	0.	20.	58.	100.
10	401	146.	0.	0.	17.	49.	100.
10	401	109.	0.	0.	13.	36.	100.
10	401	109.	0.	0.	13.	36.	100.
10	401	146.	0.	0.	17.	49.	100.
10	401	146.	0.	0.	17.	49.	100.
10	401	146.	0.	0.	17.	49.	100.
10	401	126.	0.	0.	15.	42.	100.
10	401	126.	0.	0.	15.	42.	100.
10	401	125.	0.	0.	15.	42.	100.
10	401	125.	0.	0.	15.	42.	100.
10	401	257.	0.	0.	35.	99.	100.
10	401	88.	0.	0.	10.	29.	75.
10	401	176.	0.	0.	21.	59.	75.
10	401	176.	0.	0.	21.	59.	75.
10	401	176.	0.	0.	21.	59.	75.
10	401	176.	0.	0.	21.	59.	75.
10	401	224.	0.	0.	26.	75.	75.
10	401	224.	0.	0.	26.	75.	75.
10	402	261.	0.	0.	0.	0.	75.
10	402	261.	0.	0.	0.	0.	75.
10	402	261.	0.	0.	0.	0.	75.
10	402	219.	0.	0.	0.	0.	50.
10	402	163.	0.	0.	0.	0.	50.
10	402	219.	0.	0.	0.	0.	50.
10	402	163.	0.	0.	0.	0.	50.
10	402	188.	0.	0.	0.	0.	50.
10	402	188.	0.	0.	0.	0.	50.
10	402	188.	0.	0.	0.	0.	50.
10	402	188.	0.	0.	0.	0.	50.
10	402	220.	0.	0.	0.	0.	50.
10	402	220.	0.	0.	0.	0.	50.
10	402	44.	0.	0.	0.	0.	50.
10	402	132.	0.	0.	0.	0.	75.
10	402	264.	0.	0.	0.	0.	75.
10	402	264.	0.	0.	0.	0.	75.
10	402	264.	0.	0.	0.	0.	75.
10	402	264.	0.	0.	0.	0.	75.
10	402	335.	0.	0.	0.	0.	75.
10	402	335.	0.	0.	0.	0.	75.
10	405	0.	609.	0.	0.	0.	270.
10	405	0.	609.	0.	0.	0.	270.
10	405	0.	609.	0.	0.	0.	240.
10	405	0.	487.	0.	0.	0.	0.
10	405	0.	362.	0.	0.	0.	0.
10	405	0.	575.	0.	0.	0.	0.
10	405	0.	362.	0.	0.	0.	0.
10	405	0.	837.	0.	0.	0.	0.
10	405	0.	835.	0.	0.	0.	0.
10	405	0.	837.	0.	0.	0.	0.
10	405	0.	835.	0.	0.	0.	0.
10	405	0.	488.	0.	0.	0.	0.
10	405	0.	488.	0.	0.	0.	0.
10	405	0.	1980.	0.	0.	0.	0.
10	405	0.	551.	0.	0.	0.	75.
10	405	0.	1100.	0.	0.	0.	75.
10	405	0.	1100.	0.	0.	0.	75.
10	405	0.	1100.	0.	0.	0.	75.
10	405	0.	1100.	0.	0.	0.	75.
10	405	0.	1060.	0.	0.	0.	75.

```
10          405    0.   1000.      2.        0.        0.            75.
10          426    9.      0.      0.        0.        0.           100.
10          426   10.      0.      0.        0.        0.           100.
10          426   13.      0.      0.        0.        0.           100.
10          426    6.      0.      0.        0.        0.           100.
10          426   11.      0.      0.        0.        0.           100.
10          426    8.      0.      0.        0.        0.           100.
10          426   12.      0.      0.        0.        0.           100.
10          426    8.      0.      0.        0.        0.           100.
10          426    9.      0.      0.        0.        0.           100.
10          426    8.      0.      0.        0.        0.           100.
10          426    5.      0.      0.        0.        0.           100.
10          426    5.      0.      0.        0.        0.           100.
10          426   73.      0.      0.        0.        0.             0.
10          426   73.      0.      0.        0.        0.             0.
10          426   73.      0.      0.        0.        0.             0.
10          426   73.      0.      0.        0.        0.             0.
10          426   73.      0.      0.        0.        0.             0.
10          426   73.      0.      0.        0.        0.             0.
10          426   73.      0.      0.        0.        0.             0.
10          426   73.      0.      0.        0.        0.             0.
10          427 1530.      0.      0.    16000.        0.           120.
10          427  153.      0.      0.        0.        0.           170.
10          427  134.      0.      0.    35000.        0.             0.
10          427  134.      0.      0.    35000.        0.             0.
10          427   43.      0.      0.        0.        0.           114.
10          427   43.      0.      0.        0.        0.           114.
10          427 10800.     0.      0.    11300.        0.             0.
10          427 10800.     0.      0.    11300.        0.             0.
10          427  134.      0.      0.        0.        0.           125.
10          427  134.      0.      0.        0.        0.           125.
10          427  134.      0.      0.        0.        0.           125.
10          427  134.      0.      0.    35000.        0.             0.
10          427 6490.      0.      0.    45300.        0.             0.
10          427  865.      0.      0.        0.        0.             0.
10          429   64.      0.      0.        0.        0.           100.
10          429   15.      0.      0.        0.        0.           120.
10          429  567.      0.      0.        0.        0.           100.
10          429  175.      0.      0.        0.        0.             0.
10          429   57.      0.      0.        0.        0.            58.
10          429   57.      0.      0.        0.        0.            58.
10          429   57.      0.      0.        0.        0.            58.
10          429   17.      0.      0.        0.        0.             0.
10          429   17.      0.      0.        0.        0.             0.
10          429   17.      0.      0.        0.        0.             0.
10          429   17.      0.      0.        0.        0.             0.
10          433   21.     28.      0.        0.        0.           160.
10          433   21.     28.      0.        0.        0.           160.
10          433   21.     28.      0.        0.        0.           160.
10          433   21.     28.      0.        0.        0.           160.
10          433   21.     28.      0.        0.        0.           160.
10          433   21.     28.      0.        0.        0.           160.
10          433   21.     28.      0.        0.        0.           160.
10          434  124.      0.      0.        0.        0.           100.
10          434  124.      0.      0.        0.        0.           160.
10          434  409.    107.      0.        0.        0.           160.
10          434  409.    107.      0.        0.        0.           160.
10          434  409.    107.      0.        0.        0.           160.
10          434  409.    107.      0.        0.        0.           160.
10          434  409.    107.      0.        0.        0.           160.
```

```
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       150.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434     409.   107.    0.      0.     0.       160.
10    434      15.     0.    0.      0.     0.         0.
10    434      15.     0.    0.      0.     0.         0.
10    434      15.     0.    0.      0.     0.         0.
10    434      15.     0.    0.      0.     0.         0.
10    434      15.     0.    0.      0.     0.         0.
10    434      15.     0.    0.      0.     0.         0.
10    434      15.     0.    0.      0.     0.         0.
10    434     789.     0.    0.      0.     0.         0.
10    434     789.     0.    0.      0.     0.         0.
10    434     789.     0.    0.      0.     0.         0.
10    434     789.     0.    0.      0.     0.         0.
10    434     789.     0.    0.      0.     0.         0.
10    434     789.     0.    0.      0.     0.         0.
10    434     789.     0.    0.      0.     0.         0.
10    434     789.     0.    0.      0.     0.         0.
10    434     789.     0.    0.      0.     0.         0.
10    434     789.     0.    0.      0.     0.         0.
10    435      48.     0.    0.    651.     0.       260.
10    435     225.     0.    0.   1230.     0.        99.
10    435     225.     0.    0.   1230.     0.        99.
10    435     593.     0.    0.   1020.     0.         0.
10    435     593.     0.    0.   1020.     0.         0.
10    436   28100.     0.    0.  46000.     0.        50.
10    440       7.     0.    0.      0.     0.       120.
10    477       2.    15.    0.   1740.     0.         0.
10    444      29.     0.    1.      0.     0.         0.
10    495     132.     0.    1.      0.     0.        20.
10    495    2200.     0.    2.      0.     0.         0.
10    [illegible]       0.     0.    0.      0.     0.        50.
10    522       2.     0.    0.     23.    36.       125.
10    522     129.     0.    0.     46.    77.         0.
10    525      10.     0.    0.      0.     0.        44.
10    533       2.     1.    4.      2.     1.        50.
10    533       0.     1.    4.      2.     1.        50.
10    541       7.     0.    0.      0.     0.        45.
10    541     172.     0.    0.      0.     0.        25.
10    544       2.     0.    0.      0.     0.        37.
10    546      12.     0.    0.      0.     0.        10.
```

```
 10     546      4.       0.      0.        0.      0.          10.
 10     546     33.       0.      0.        0.      0.          32.
 10     547     20.       0.      0.        0.      0.         127.
 10     581   3500.      58[illegible].     0.        0.      0.         103.
 10     589    150.       0.      0.        0.      0.         110.
 10     590     10.       0.      0.        0.      0.         100.
 10     591     20.       0.      0.        0.      0.         100.
 10     633     35.     688.    120.        0.      0.         125.
 10     633    101.    1300.    348.        0.     17.         150.
 10     633    245.   14300.    845.        0.     41.         144.
 10     633     20.     339.     65.        0.      3.         126.
 10     633     39.    1110.    133.        0.      6.         175.
 10     633     54.    1670.    186.        0.      9.         175.
 10     633     53.    1390.    183.        0.      9.         125.
 10     633     59.    1430.    204.        0.     10.         125.
 10     634     22.    4390.    252.        0.     33.         125.
 10     634      1.     148.      5.        0.      1.         144.
 10     634      3.     204.     39.        0.      5.         126.
 10     634      3.     521.     40.        0.      5.         175.
 10     634      3.     315.     35.        0.      5.         175.
 10     634     12.     939.    130.        0.     18.         125.
 10     634      9.     675.    106.        0.     14.         125.
 10     634      4.     436.     43.        0.      6.         175.
 10     637    835.     230.    337.    98000.   1040.         178.
 10     637   1100.    2180.    572.   110000.   1770.         165.
 10     638    265.    1050.     87.        0.      0.         267.
 10     638      4.    2690.      1.      588.     23.         155.
 10     650      0.       0.      0.        0.    126.          30.
 10     657      0.     162.      0.        0.      0.         100.
 10     657      0.    4240.      0.        0.      0.         100.
 10     657      0.    4650.      0.        0.      0.         165.
 10     657      0.     148.      0.        0.      0.         140.
 10     657      0.    8500.      0.        0.      0.         214.
 10     657      0.    7300.      0.        0.      0.         124.
 10     657      0.    2740.      0.        0.      0.          30.
 10     657      0.     547.      0.        0.      0.         125.
 10     657      0.     146.      0.        0.      0.         195.
 10     657      0.    8500.   2630.   166000.      0.         214.
 10     658      0.    2160.    557.        0.      0.          70.
 10     658      0.       0.      0.        0.    220.         101.
 10     658      0.     547.      0.        0.      0.          50.
 10     658      0.       0.      0.        0.    182.          50.
 10     658      0.    2740.   1210.        0.      0.         165.
 10     658      0.       0.      0.        0.    182.         125.
 10     658      0.    7300.      0.        0.      0.         124.
 10     706      0.      15.      0.        0.      0.           0.
 10     714      0.      28.      0.        0.      0.         160.
 10     714      0.      28.      0.        0.      0.         160.
 10     714      0.      28.      0.        0.      0.         160.
 10     714      0.      28.      0.        0.      0.         160.
 10     714      0.      28.      0.        0.      0.         160.
 10     714      0.      28.      0.        0.      0.         160.
 10     714      0.      28.      0.        0.      0.         160.
 10     714      0.      26.      0.        0.      0.         160.
 10     737      7.     410.     89.        0.     15.         100.
 10     737      0.     120.      0.        0.      0.           0.
 10     737      3.     142.     30.        0.      5.         100.
 10     737      3.     164.     35.        0.      6.         100.
 10     737      4.     229.     50.        0.      8.         700.
 10     744      0.       0.      0.        0.      4.          22.
 10     746      0.       0.      0.        0.      9.          60.
```

10	747	0.	0.	0.	0.	92.	90.
10	749	0.	0.	0.	0.	2770.	125.
10	751	0.	0.	0.	0.	2770.	50.
10	770	3.	1.	1.	[illegible]	3.	140.
10	802	1.	1.	1.	2.	5.	0.
10	821	10.	21.	3.	87.	2.	25.
10	822	79.	495.	12.	355.	79.	25.
10	823	172.	979.	207.	86.	52.	25.
10	825	200.	6.	526.	210.	84.	25.
10	826	4.	0.	1.	0.	0.	25.
10	828	11274.	12084.	1445.	193.	56.	25.
10	829	28.	290.	74.	0.	4.	25.
10	830	74.	282.	298.	1.	15.	25.
10	831	161.	6.	1613.	4.	403.	25.
10	835	1186.	2848.	209.	164.	45.	25.
10	836	9.	54.	24.	0.	1.	25.
10	837	214.	809.	854.	3.	43.	25.
10	838	48.	2.	253.	51.	20.	25.
10	840	729.	12.	24.	7290.	2430.	25.
10	841	299.	19.	112.	1589.	630.	3.
10	842	97.	12.	16.	162.	81.	25.
10	843	100.	6.	37.	531.	212.	3.
10	844	904.	113.	151.	1507.	753.	25.
10	845	202.	38.	228.	3200.	1280.	25.
10	846	954.	573.	13678.	180679.	31173.	3.
10	847	118.	71.	3931.	37860.	8807.	3.
10	848	33.	20.	720.	12393.	2202.	3.
10	849	175.	350.	4958.	2910.	490.	3.
10	850	65.	135.	1848.	1124.	185.	3.
10	851	149.	369.	448.	419.	249.	25.
10	856	51.	133.	153.	143.	132.	25.
10	857	199.	200.	220.	2.	20.	25.
10	858	1.	1.	29.	501.	92.	25.
10	859	0.	0.	0.	0.	2759.	3.
10	861	0.	0.	0.	0.	5654.	25.

EMISSION SOURCES IN PORTER COUNTY

COUNTY #	SOURCE #	PM	SOX	NOX	CO	HC	HEIGHT, FT.
11	10	250.	46300.	1200.	331.	99.	400.
11	10	374.	19900.	590.	143.	43.	400.
11	36	5.	54.	60.	2.	1.	220.
11	36	5.	54.	60.	2.	1.	220.
11	36	5.	54.	60.	2.	1.	220.
11	36	5.	54.	60.	2.	1.	220.
11	36	5.	54.	60.	2.	1.	220.
11	39	1.	0.	6.	1.	1.	220.
11	39	1.	0.	6.	1.	1.	220.
11	39	1.	0.	6.	1.	1.	220.
11	39	1.	0.	6.	1.	1.	220.
11	39	1.	0.	6.	1.	1.	220.
11	42	1.	1.	91.	39.	2.	400.
11	42	4.	1.	181.	38.	2.	400.
11	42	4.	1.	160.	5.	1.	220.
11	42	4.	1.	160.	5.	1.	220.
11	42	4.	1.	160.	5.	1.	220.
11	42	4.	1.	160.	5.	1.	220.
11	42	4.	1.	160.	5.	1.	220.

```
 11          45     87.       0.    3480.      99.       6.          220.
 11          45     87.       0.    3480.      99.       6.          220.
 11          45     87.       0.    3480.      99.       6.          220.
 11          45     87.       0.    3480.      99.       6.          220.
 11          45     87.   89[illegible]    3480.      99.       6.          220.
 11         105     13.    1370.     204.      15.       3.          220.
 11         105     13.    1370.     204.      15.       3.          220.
 11         105     13.    1370.     204.      15.       3.          220.
 11         105     13.    1370.     204.      15.       3.          220.
 11         399   1230.       0.      14.     445.    1470.          100.
 11         399   1230.       0.      14.     445.    1470.          100.
 11         400     11.       7.      11.      11.      44.          100.
 11         400     11.       7.      11.      11.      44.          100.
 11         401    210.       0.       0.      25.      70.          100.
 11         401    210.       0.       0.      25.      70.          100.
 11         402     32.       0.       0.       0.       0.            0.
 11         402     32.       0.       0.       0.       0.            0.
 11         426     29.       0.       0.       0.       0.          200.
 11         426     29.       0.       0.       0.       0.          200.
 11         429     53.       0.       0.       0.       0.           71.
 11         435    383.       0.       0.    1040.       0.          222.
 11         435    383.       0.       0.    1040.       0.          222.
 11         435    383.       0.       0.    1040.       0.          222.
 11         579      0.       0.       0.       0.      79.           66.
 11         737      0.    1430.       0.       0.       0.          255.
 11         737      0.    1430.       0.       0.       0.          255.
 11         821      1.       2.       0.       8.       0.           25.
 11         822      7.      40.       1.      33.       7.           25.
 11         823     30.     171.      36.      15.       9.           25.
 11         825     30.       1.      80.      32.      13.           25.
 11         828    806.     863.     103.      14.       7.           25.
 11         829      2.      21.       5.       0.       0.           25.
 11         830      5.      20.      21.       0.       1.           25.
 11         831     13.       0.     130.       0.      29.           25.
 11         835    189.     455.      33.      26.       7.           25.
 11         836      1.      15.       4.       0.       0.           25.
 11         837     34.     129.     136.       0.       7.           25.
 11         838      8.       0.      40.       8.       3.           25.
 11         840    110.       2.       4.    1162.     397.           25.
 11         841     48.       3.      18.     255.     102.            3.
 11         842     10.       2.       3.      26.      13.           25.
 11         843     16.       1.       6.      85.      34.            3.
 11         844     58.      12.      16.     163.      47.           25.
 11         845     65.       4.      24.     344.     138.           25.
 11         846    147.      88.    2106.   24582.    4505.            3.
 11         847     18.      11.     605.    5150.    1247.            3.
 11         848      9.       6.     198.    3410.     622.            3.
 11         849     27.      34.     703.     449.      76.            3.
 11         850     18.      37.     593.     306.      50.            3.
 11         851     24.      62.      72.      67.      48.           25.
 11         856     13.      34.      39.      36.      26.           25.
 11         857     30.     120.      77.       0.       4.           25.
 11         858      0.       0.       3.      56.      10.           25.
 11         859      0.       0.       0.       0.     436.            3.
 11         861      0.       0.       0.       0.     248.           25.
```

APPENDIX E

MAXIMUM POSSIBLE CHANGE IN TWO SETS OF POPEX VALUES

To calculate the maximum possible changes between two sets of popex levels, or in other words, between two sets of numbers both of which add up to 100:

Let $a_1, a_2, . . . a_n$ and $b_1, b_2, . . . b_n$ be the two sets, such that:

$$\sum_{i=1}^{n} a_i = 100 \qquad \text{all } a_i \geqslant o$$

and

$$\sum_{i=1}^{n} b_i = 100 \qquad \text{all } b_i \geqslant o$$

In order to find the maximum value of $\sum_{i=1}^{n}$ absolute $(a_i - b_i)$:

$$\sum_{i=1}^{n} \text{absolute } (a_i - b_i) = |a_1 - b_1| + |a_2 - b_2| + . . . + |a_n - b_n|$$

each of the $|a_i - b_i|$ has to be maximized. For this to be true, either a_i or b_i has to be zero for all values of n. Therefore the preceding equation can be rewritten as

$$\sum_{i=1}^{n} \text{absolute } (a_i - b_i) = |a_1| + |a_2| + . . . + |a_n| + |b_1| + |b_2| . . . + |b_n|$$

$$= \sum_{1}^{n} a_i + \sum_{1}^{n} b_i$$

By definition, $\sum_{1}^{n} a_i = 100$ and $\sum_{1}^{n} b_i = 100.$

Thus the maximum possible total change in two sets of popex levels is 200.

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(Please read Instructions on the reverse before completing)

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16. ABSTRACT

The report gives results of research to develop quantitative models for relating emissions of air pollutants to their effects on people, and to use the methodology for determining the relative importance of air pollution sources. The quantitative methodology for ranking the sources developed in this project includes consideration of the dispersion of air pollutants, exposure of people, and subsequent health effects. The computer model, called POPEX, consists of three submodels: dispersion, population, and health effects. The model was applied to sources of air pollution in the Chicago Air Quality Control Region. Results show that 17 of 227 categories of sources contribute nearly 80% of the total air-pollution/population-effect problem.

17. KEY WORDS AND DOCUMENT ANALYSIS

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Mathematical Models	POPEX	12A
Dispersing	Emissions	07A,08H
Health	Effects	06N
Exposure	Population Effect	06F
Ranking		12B
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